REPORT RESUMES

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SUBSTRATA-FACTOR REORGANIZATION ACCOMPANYING DEVELOPMENT IN SPEED AND POWER OF READING AT THE ELEMENTARY SCHOOL LEVEL.
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SEVERAL DEVELOPMENTAL HYPOTHESES DRAWN FROM THE SUBSTRATA-FACTOR THEORY OF READING WERE TESTED AT THE ELEMENTARY SCHOOL LEVEL. TO ELABORATE ON THEORETICAL ASSERTIONS THAT READING ABILITY IS AN AUDIOVISUAL PROCESSING SKILL OF SYMBOLIC REASONING, THE SUBSTRATA FACTORS ACCOMPANYING DEVELOPMENT OF SPEED AND POWER OF READING WERE DEPICTED IN DIAGRAMMATIC MODELS. THE EXPERIMENTAL DESIGN CONSISTED OF (1) SELECTION OF A BATTERY OF TESTS FOR PREDICTING SPEED AND POWER OF READING, (2) ADMINISTRATION OF THIS BATTERY TO REPRESENTATIVE PUPILS IN GRADES THREE THROUGH SIX, AND (3) STATISTICAL TESTS OF HYPOTHESES BY MEANS OF MULTIPLE CORRELATION, SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS OF KNOWN GROUPS, AND FACTOR ANALYSIS. THE SAMPLE CONTAINED 927 PUPILS IN GRADES THREE THROUGH SIX IN SIX ELEMENTARY SCHOOLS IN AN AVERAGE SOCIOECONOMIC DISTRICT. DEVELOPMENTAL HYPOTHESES OF THE SUBSTRATA-FACTOR THEORY WERE CONFIRMED. SPECIFIC FINDINGS INDICATED THAT (1) SEQUENTIAL DEVELOPMENT OF A HIERARCHICAL ORGANIZATION OF SUBSTRATA-FACTORS DID ACCOMPANY IMPROVEMENT IN SPEED AND POWER OF READING, (2) VISUAL PROCESSES WERE DOMINANT FOR SPEED OF READING, BUT BOTH VISUAL AND AUDITORY PROCESSES CONTINUED TO OPERATE IN POWER OF READING THROUGHOUT THE INTERMEDIATE GRADES, (3) SHIFT IN INSTRUCTIONAL EMPHASIS DURING THESE GRADE TOWARDS WORD MEANING AND REASONING-IN-CONTEXT ABILITIES AND PROCESSES WAS TO SOME DEGREE CONSISTENT WITH DEVELOPMENTAL CHANGES, (4) THE AVERAGE READER DEVELOPED MORE OR LESS AT AN EVEN RATE IN ALL OF HIS SUBABILITIES AND IN SPEED AND POWER OF READING THROUGHOUT THE INTERMEDIATE GRADES, AND (5) DURING GRADES THREE THROUGH SIX, THE SLOWEST AND LEAST POWERFUL READERS WERE APPROXIMATELY THREE GRADES BEHIND THE DEVELOPMENT OF THE FASTEST AND MOST POWERFUL READERS. (JM)

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SUBSTRATA-FACTOR REORGANIZATION ACCOMPANYING DEVELOPMENT IN SPEED AND POWER OF READING AT THE ELEMENTARY SCHOOL LEVEL

by

Harry Singer
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Final Report
Covering Contract Number 2011

The research reported herein was supported through the Cooperative Research Program of the Office of Education, U. S. Department of Health, Education, and Welfare.

John Gardner
Secretary

Francis Keppel
Commissioner

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Multilithed at the Duplication Center
of the University of California, Riverside
1965

ACKNOWLEDGMENTS

About six years ago, I first heard the statement made by Professor Roy Hall, then Assistant Commissioner of the U. S. Office of Education, that research ideas evolve gradually in the minds of researchers. Although it is true that the hypotheses tested in this study did evolve in my mind over a long period of time, the funds from the U. S. Office of Education which supported this research made it possible for me to put them to an empirical test. I wish to thank Dr. William Carriker and Dr. Doris Gunderson of the U. S. Office of Education for their administrative work on this project.

I can trace the origin of the ideas for this study to the time when I was a graduate student in psychology. My interest in the psychology of reading began when Professor Holmes introduced me to the substrata-factor theory of reading which he had recently formulated. Later, while taking a course from Professor Guy T. Buswell, I attempted to integrate substrata-factor theory with his implicit theory on the development of general reading ability. My conception of the psychology of reading was further enhanced by courses and conversations with Professor Luther C. Gilbert. I became even more curious about the structure and dynamics of reading development and improvement as a result of teaching reading in the intermediate grades in Oakland, California and in the reading improvement center at the University of California, Berkeley under the direction of Mrs. Doris W. Gilbert. I was also encouraged by the late Professor David H. Russell in my efforts to investigate children's thinking as manifested in their behavior in reading.

The specific hypotheses for the current investigation grew out of the results of two studies that were completed in 1960 and 1961. Both

of these studies were also supported by the U. S. Office of Education under Contract 538 and 538A. In the first, the generality of the major hypothesis of the substrata-factor theory of reading was confirmed by finding that this hypothesis which had previously been confirmed only at the college level was also tenable at the fourth grade level. In the second, the hypothesis was tested and confirmed at the high school level that such known-groups as (a) boys vs. girls, (b) fast vs. slow, and (c) least vs. most powerful readers mobilize different organizations of abilities and capacities to attain speed and power of reading. The monograph which resulted from these two studies is now in the process of being published by the U. S. Office of Education.[1]

Since 1962 when the proposal for the current study was submitted to the U. S. Office of Education, many people at the University and in the public schools have participated in various aspects of the project. My appreciation of their contributions is not diminished by the fact that space limitations preclude me from citing all of them by name.

Preliminary data on some of the variables assessed in this study were obtained by testing pupils at the Sunnymead Elementary School in Moreno Valley, California. These tests were administered and scored by Mr. Les Darkens and Miss Elberta Hurt, who also participated in the subsequent large scale investigation.

In the major study, conducted in Alvord, California, approximately 1,000 pupils in grades 3, 4, 5, and 6 took the entire battery of tests. The tests were administered and scored by the following group of seniors at the University of California, Riverside who were then preparing to become elementary teachers and are now mostly practicing teachers in various parts of the United States; two of them are now in the Peace Corps in Chile and Peru:

---

[1] Holmes, Jack A. and Singer, Harry. Speed and Power of Reading. U. S. Office of Education Monograph Series, No. 13. Washington, D. C.: Government Printing Office, in press.

Margo Alexandre
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Lura Sevier
Nancy Stromberg
Jennifer Walton
George Whinnery

Three secretaries have worked on various phases of the project. Mrs. Rosie Russell has done an excellent job of taking care of all the bookkeeping, ordering, and letter writing that was necessary for this research project over the past two years. Miss Janet Curran, who is now an intern teacher, typed the penultimate manuscript; she willingly adapted her summer plans to the demands of the project. Mrs. Betty Medved typed all of the interim research reports and the final manuscript for this project. I deeply appreciate Mrs. Medved's concern for and achievement of excellence in all aspects of her work.

I have been most fortunate to have had Mr. Price Stiffler, a graduate student in mathematics and logic at the University of California, Berkeley, serve as computer programmer for this project. He modified the IBM 704 Substrata Analysis Program so that it could be used on the IBM 7090, and wrote, together with Dr. Frank Davis, a "BYSUBJ" program, which, in conjunction with other programs, resulted in a plotted profile of scores for each of the 927 pupils in the project. Assistance in various phases of processing the data on this project for the IBM 7090 Computer at the University of California, Berkeley Computer Center was also rendered by the following people who are employed on the Berkeley Campus of the University of California: Mrs. Penny Gee, Keypunch Supervisor; Mr. Phil Duell and Mrs. Ruth Iscol, Computer Center Consultants, who prepared Statpak, the executive program used in this study in conjunction with Substrata Analysis; Mrs. Ellie Krasnow, Programmer for the Psychology Department, who wrote Prep and t-test programs which were employed in this project for the Analysis by Correspondence; and Dr. Alan Wilson, Assistant Professor of Education, who programmed an integrated Principal Components Factor Analysis and Varimax program, which was used in this investigation for the Factor Analyses. I am very pleased to have had Professor Henry Kaiser, now at the University of Wisconsin, apply his and Mr. Bianchini's recently developed "Relating Factors Program" to the results of the Factor Analyses.

I also wish to acknowledge my wife's contribution to this project. She prepared one of the figures and readily adapted our household routine and daughter to the project's varying time schedule, particularly during the preparation of the final report.

The multitude of arrangements and accommodations entailed by a project of this magnitude were facilitated by the administrative skill of my department chairman, Dr. Irving Balow. I also appreciate the understanding, support, and encouragement he gave me throughout the entire project.

I am grateful to the large numbers of elementary pupils who took the tests, their teachers who assisted, the principals of the schools who cooperated, and the administrative staffs in the Riverside County

Superintendent of Schools' Office and in the Moreno Valley and Alvord Unified School Districts who opened the doors to this research and to further understanding of the development of general reading ability.

Lastly, I would like to acknowledge that Professor Holmes served as statistical and psychological consultant to this study. In this role, he was consulted on every phase of the investigation. For his fine contributions to this study, for his many other excellent contributions to the psychology and the teaching of reading and especially for his formulation and continued development of the substrata-factor theory of reading, I am dedicating this monograph to him.

Harry Singer,
Principal Investigator

To

Jack A. Holmes

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ERRATA

Page	Line	Correction
ii	footnote	See list of References for complete reference.
iv	6, 8	Capitalize STATPAK, PREP, T-TEST
iv	21	Should be "was facilitated"
8	18	"Holmes and Singer, 1965" should be "Holmes and Singer, 1966" throughout the monograph.
12	12	Insert comma after "subskill"
15	5	Should be "Holmes 1954a" wherever "Holmes 1954" appears.
26	3	Van Wagenen and Dvorak
33	19	Auditory Picture Meaning
44	14	Examples
49	9	11.0 should be 11-0
79	22	Change "abstracting them" to "abstracting elements"
104	2	"an as" should be "as an"
112	9	"Singer, 1965b" should be "Singer, 1964b"
127	11	Omit "that" at beginning of line
128	20	Change 107 to 108
149	8	Insert comma after "variables"
151	10	After "Auding," insert "and on such perceptual discrimination variables as"
169	26	Change "commonality" to "communality." Also, make same change on page 170, line 3.
179	25	Insert semicolon after "Perception"
181	3	"one" should be "another"
181	footnote 1	Omit "1965."
190	7	Change "a" to "an"
190	15	After "Power of Reading," insert "At the fifth grade, Visual Verbal Conceptualization accounted for some of the variance in Word Recognition in Context, which makes a direct contribution to variance in Power of Reading."
192	2	After "Auding," insert "and on such perceptual discrimination variables as"
193	15	"account" should be "accounted"
197	21	Should be "occurring"
204	18	"1965g" should be "Singer and Balow, 1965"
205	20	Insert reference: Brownell, William A. Rate, accuracy, and process in learning. Abridged by Theodore L. Harris and Wilson E. Schwahn, Selected Readings on the Learning Process. New York: Oxford University Press, 1961, 388-400.

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SUBSTRATA-FACTOR REORGANIZATION ACCOMPANYING DEVELOPMENT IN SPEED AND POWER OF READING

by

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CHAPTER I: THEORY AND PROBLEM[1]

The substrata-factor theory of reading is an explanation of the mental structure and dynamics involved in reading ability (Holmes, 1948, 1953, 1954a, 1960; Singer, 1960; Holmes and Singer, 1961, 1964; Davis, 1963, 1964). The theory asserts that general reading ability is an audio-visual processing skill of symbolic reasoning. This ability divides into two major interrelated components: speed and power of reading. Underlying and supporting each component is a functionally organized hierarchy of complexly interwoven neurological subsystems (Davis, 1965). These subsystems, which gradually develop as an individual learns to read, can be categorized as interrelated input (sensation and perception of stimuli), mediational (interpreting, inferring, and integrating ideas), and output (response formulation) subsystems. Coupled by short and long term memory processes, these subsystems are then available for mobilization into working systems for attaining speed and power of reading (Holmes and Singer, 1964). The organization and operation of each working system is influenced not only by the individual's cognitive system (Holmes and Singer, 1961; Kling, 1965), but also by his attitudinal, emotional, value (Athey, 1965), and biological support systems (Davis, 1964).

---

[1] This final report draws upon interim results of this project that were presented in invitational papers read at the International Reading Association (Singer, 1964a, 1965d, 1965e), National Council of Teachers of English (Singer, 1964b), the National Reading Conference (Singer, 1964c) and in a research paper read at the American Educational Research Association (Singer, 1965b).

Subsystems are composed of substrata-factors. Each substrata-factor contains information stored in cell assemblies (Hebb, 1949). This information has been acquired from instruction and learning in such broadly defined areas of reading as word recognition, word meaning, and reasoning-in-context (Singer, 1960). As a result of maturation, instruction, and practice in reading, these cell assemblies are organized into substrata-factors, which can be mobilized to form neurological subsystems.

In response to the interacting and changing purposes of the reader and the demands of the reading task, the mobilization process selects the necessary substrata-factors and orders them into a functional neural communication network or working system for solving a particular reading task. At one moment, the reader may mobilize a working system to recognize a word, at another instant to associate meaning to the word, and at still another time to integrate, conceptualize, transform, or encode ideas for an overt response. Throughout his reading, the individual not only mobilizes working systems at various levels of his general organization for power of reading, but he also switches from power to speed of reading. As he does, he changes from a working system that enabled him to read difficult materials somewhat analytically and mobilizes into another working system those substrata-factors that permit him to read relatively easy material at a faster rate. Hence, subsystems are constantly being mobilized, modified, or reorganized according to the reader's changing purposes and the shifting demands of the perceived task.

At maturity in reading, an individual's working system functions fluently and flexibly. But, in the initial stages of learning to read, an individual's attempts to mobilize his developing subsystems into a working system for responding to the printed page are characterized by hesitancy, rigidity, and frequent lack of success because he does not yet have adequately developed subsystems nor the necessary mental structure and flexibility for changing appropriately from one working system to another (Inhelder and Piaget, 1958; Laycock, 1962). Gradually, however, his subsystems improve in variety, magnitude, and intercommunicability as a result of maturation, learning, and experience in mobilizing subsystems. The individual thus develops the ability to shift from one mental organization to another. Therefore, he can be more flexible in organizing and reorganizing subsystems. Consequently he can be more effective and efficient in the process of reading.

At first, however the individual can only mobilize relatively simple working systems, consisting perhaps of only some associations to printed words or letters. If the individual were to continue to acquire, store, and utilize only simple associations, he would eventually reach a point of cognitive overload because of the complexity of printed English. Instead of a separate response for each non-identical printed stimulus, an individual who has the capability and receives appropriate instruction can develop auditory, visual, and kinesthetic concepts that effectively reduce the complexity of printed English (Singer, 1965a). By mentally grouping printed words according to some common characteristics, which can then be abstracted and generalized within limitations of printed English, an individual could thus conceptualize input stimuli and subsequently utilize his concepts for selective perception of and response to printed stimuli. For example, an *auditory concept* could be formed for the common element that is visually different in such words as "m*y*, *ais*le, *eye*, tr*ied*," and "h*igh*;" a *visual concept* could be constructed for the common visual, but auditorily dissimilar element in such words as "c*ough*" and "th*ough*;" and a *kinesthetic concept* could be abstracted from eye-movement response-sensations to the characteristic lines and curves for any letter, such as the up-and-down-and-across characteristics in "*T*om, *t*ree," and a cursively written word "boa*t*" (Hebb, 1949; Singer, 1960).

Because of his growing capability, the individual is increasingly able to conceptualize stimuli not only in his input, but also in his mediational processing systems. Therefore, as an individual progresses through the grades, he becomes more and more capable of forming and mobilizing conceptual systems that are appropriate for responding to various stimulus categories and for integrating more widely dispersed ideas (Singer, 1960; Bruner and Olver, 1963). By integrating his experiences to a printed word, an individual could thus develop a conceptualized meaning-response, even in the initial stage of reading. For example, an individual might have had a tangible experience with a toy boat in which he manipulated the boat and thus acquired kinesthetic, visual, and often gustatory images of the boat. Later he might have heard someone refer to the object he had manipulated as a "boat." Still later he may have acquired further knowledge about boats. When he learns to read, he may mobilize these images and information into an organized response to give meaning to the printed word. Of course, from the reading readiness stage on throughout the curriculum, reading instruction could be designed to facilitate the development of increasingly more abstract conceptualized responses to printed words (Singer and Balow, 1965).

Conceptualization or hierarchical organization can thus reduce "cognitive strain" (Bruner, Goodnow, and Austin, 1956) in an individual's perceptual, storage, retrieval, and response systems. If an individual also accumulates or fuses meaning as he reads, he could utilize "word sense" (Holmes, 1948) or "sentence sense" (Lefevre, 1964) for judging whether his working system is adequate to the task or should be switched to a more appropriate organization for perceiving and reacting to printed words. Utilization of sentence sense may not only signalize the necessity of a shift from one mental organization to another, but may also act as an advance mobilizer for selecting responses to multiple meaning words. An advance mobilizer is particularly necessary for such word categories as homographs (rēad and rĕad) and homonyms (meet and meat). If an individual cannot or does not utilize such conceptualization and meaning processes, then his rate of learning to read is likely to be slower and his working system for attaining speed and power of reading will tend to be more cumbersome and less effective and efficient.

With continued development, instruction, and practice in reading progressively more challenging material and concomitant increases in experience and mental maturation, an individual gradually forms his substrata-factors into an hierarchical organization of word-recognition, word-meaning, and reasoning-in-context subsystems (Singer, 1962). When the necessary subsystems have been developed and can be mobilized in proper order and magnitude, the individual attains working systems for speed and power of reading that function fluently and harmoniously. However, increased speed and power of reading are not only related to changes in magnitude and variety of available substrata-factors but also to a more mature organization and a greater degree of integration among substrata-factors. Consequently, there is more interfacilitation among the substrata-factors that have been mobilized into a working system. Therefore, as an individual improves in reading ability, he is increasingly more able to mobilize rapidly and flexibly an hierarchical organization of subsystems in which a minimum of mental energy is devoted to his input system and a maximum is expended upon his mediational and output systems.

As a part of a developmental reorganization in his general working system that can be mobilized for attaining speed and power of reading, an individual, in general, goes through a gradient-shift in modality dominance in which he relies more and more upon visual modes of perception and less upon auditory and even less upon kinesthetic. At each stage, the individual utilizes his growing capability to conceptualize within appropriate limits and gradually becomes versatile in shifting appropriately from one perceptual category and from one level of meaning to another. Moreover, as a result of practice and the development of a wide repertoire of subskills and abilities, his word-recognition-substrata and word-meaning-substrata begin to psychosynchromesh, and the individual can then concentrate more of his mental energy upon his reasoning-in-context substrata. Gradually the individual not only improves in speed and power of reading, but also in the dominant process by which he attains these products of his general working system. At maturity, therefore, as a consequence of maturation, developmental instruction, and practice, his working systems, in general, function smoothly with a dominance of visual over auditory processes for reasoning from printed symbols.

Many kinds of working systems for attaining speed and power of reading result from individual differences in (a) rate of maturation and degree of capacities, (b) method, sequence, and degree of learning, (c) background experiences and range of resulting ideas (Kling, 1965), and (d) temperament and motivation, as well as energy level (Davis, 1964) and values (Athey, 1965). These differences are manifested in the kinds and relative amounts of substrata-factors which each individual mobilizes into a working system to solve a task. Consequently, the degree of achievement attained, the processes underlying the solution of a task, and the resulting cognitive style in reading may vary from person to person. However, there is more than one route to the goal of success in reading; that is, two individuals may attain the same degree of achievement, but by means of different working systems (Holmes and Singer, 1961).

In essence, the substrata-factor theory of reading is an explanation of the development, structure, and dynamic functioning of an intellect that is increasingly able to transform symbolic stimuli into meaningful mental processes and then purposefully interrelate these processes by various mediational systems in order to efficiently and effectively comprehend and react to the thoughts of another person as expressed in his written words.

PROBLEM

The purpose of this study is to test at the elementary school level the following developmental hypotheses drawn from the substrata-factor theory of reading:

1. The major developmental hypothesis of the substrata-factor theory of reading states that as an individual learns to read, he sequentially

develops an hierarchically organized structure of interrelated neuropsychological subsystems. Improvement in speed and power of reading result not only from changes in the magnitude of substrata-factors which comprise an individual's subsystems, but also from the way in which his subsystems are organized. According to this hypothesis, two individuals could have quantitatively identical subsystems but one individual might still read better or more rapidly than the other because of a superior integration or a more mature organization of his subsystems.

Although the combination of subsystems that can be organized into a working system for attaining speed and power of reading may vary from individual to individual, at least at the high school level, known-groups of individuals, such as boys vs. girls or fast vs. slow readers, if they are to read at all, must mobilize certain necessary subsystems, whether these subsystems draw upon strengths or weaknesses in their substrata-factor repertoire. However, the working systems of known-groups of individuals, according to their unique patterns of strengths and weaknesses, vary quantitatively and qualitatively around this common structure (Holmes and Singer, 1961, 1964, 1965). This evidence at the high school level is consistent with the hypothesis that there is for the average reader at each grade level a common structure or general working system for attaining speed and power of reading. Moreover, it would seem that this common structure would undergo systematic changes as individuals, in general, develop towards maturity in speed and power of reading. The purpose of this study, therefore, was to test this developmental hypothesis by determining for the average reader in grades 3 through 6 whether (a) his substrata-factors and the variables which assess these factors have systematic changes in magnitude and (b) his general working system that could be mobilized for attaining speed and power of reading undergoes a reorganization in substrata-factors concomitantly with improvement in general reading ability. Hence, if the hypothesis is confirmed, the specific problem is to discover (a) which of these variables and substrata-factors change and to what degree and (b) whether substrata-factors have concomitant changes in organizational position in his general working system as the average individual improves in speed and power of reading.

2. A minor hypothesis of the substrata-factor theory of reading states that as an individual, in general, starts to learn to read, his visual input and mediational processing subsystems must receive stimulation from his kinesthetic and/or auditory subsystems, if he is to respond with meaning to the printed word. This stimulation communicates kinesthetic and auditory meanings which had previously been acquired from direct contact with objects and from auditory experiences associated with these objects. At first, the individual must depend upon these modalities to give meaning to the stimuli which are taken in and processed in the visual modality (Holmes, 1957). However, as the individual matures in reading, his visual modality becomes less dependent upon his auditory and even less upon his kinesthetic modalities for giving a meaningful response to printed stimuli (Holmes, 1953). Thus, there are developmental changes in an individual's reading processes that accompany improvement in speed and power of reading.

Specifically, therefore, the hypothesis to be tested is that as an individual, in general, matures in reading ability his general working system goes through a developmental reorganization in which there is a gradient shift in modality dominance: visual subsystems will become increasingly more dominant than auditory subsystems in his general working system for attaining speed and power of reading. That is, substrata-factors that are based upon variables which assess the visual rather than the auditory domain will precipitate in the average individual's general working system hierarchy at a level that is at or closer to his first level predictors of speed and power of reading as he improves in these components of general reading ability during the upper grades of elementary school. Consequently, one individual could be a faster or better reader than another not because of superior subabilities or capacities for reading, but because his general working system is organized at a more advanced developmental level in which a more mature process can be mobilized for attaining speed and power of reading.

Theoretical significance. Because the problem is based upon hypotheses derived from the substrata-factor theory of reading, the results of this study will have theoretical implications. If the hypotheses are confirmed, as stated, they will provide further confirmatory support to the theory; if not confirmed, the hypotheses will have to be changed, the theory will not gain in support, and, perhaps, the theory itself may have to be modified (Singer, 1965d).

Educational significance. The problem may be restated in terms that are more meaningful to the classroom teacher. In grades 3 through 6, the average scores of pupils on speed and power of reading, plus many other subabilities, increase each year (Singer, 1964a). Pupils within these grades, however, vary widely not only in speed and power of reading, but also in a multitude of interrelated subabilities, such as phonics, knowledge of affixes, vocabulary, conceptual abilities, and many other variables which teachers instructionally emphasize in the belief that development of such subabilities will effect improvement in speed and power of reading. The teacher, however, might ask the following questions: (a) Which of these subabilities are, in fact, related to improvement in speed and power of reading? (b) Since these subabilities overlap greatly with each other and since instructional time is limited, what are the fewest subabilities that will most tend to account for individual differences in speed and power of reading at each grade level? (c) Although there are individual differences in patterns of subabilities and capacities that could be used for attaining speed and power of reading, is there nevertheless some common pattern of subabilities and capacities associated with the development of speed and power of reading for the average individual in each grade level around which individual patterns may vary? (d) Is there a sequence in which these subabilities are learned and used in attaining speed and power of reading in the average reader as he progresses through the upper elementary grades? (e) Does the average pupil tend to reorganize his pattern of subabilities and capacities, perhaps calling more upon vocabulary knowledge and conceptualization abilities and less upon phonics and even less upon fine perceptual discriminations, as he improves in speed and power of reading? (f) As a pupil shifts from oral to silent reading, does he also change his process of reading so that he relies increasingly more upon visual than upon auditory and kinesthetic processes? (g) If it is necessary to have pupils learn or develop further in a particular subability, such as Matching Word Sounds, that is associated with power of reading, besides providing instruction and practice in the subability itself, what other subabilities are directly associated with Matching Word Sounds that might also need to be developed and which then might facilitate improvement in power of reading (Singer, 1960)?

If teachers knew the answers to such questions, they could make more rationally-based decisions about the scope and sequence of the curriculum for teaching reading and they could also use this knowledge as a guide for more precise developmental instruction (Singer, 1962). For example, two individuals could attain the same speed of reading, but one may have minimized his potential attainment by utilizing an immature process, such as auditory word perception, while the other may have maximized his achievement by calling upon a more mature subskill such as visual word recognition. For the former pupil, the teacher can then formulate the specific objective of having him develop and mobilize into his working system the more mature process. Thus by concentrating instruction on such relevant variables, teachers theoretically could more effectively and efficiently develop pupils into faster and better readers.

In summary, the insight gained from the substrata-factor theory of reading and knowledge of the working systems that can be mobilized at successive grade levels should enable the teacher to be (a) more versatile in formulating objectives for the class, (b) more efficient in subgrouping students for the development of particular subskills, and, in general, (c) more knowledgeable in providing for individual differences in achieving speed and power of reading at increasing levels of maturity in reading. Therefore, the practical outcome of this study is to provide teachers and curriculum makers with statistically-determined developmental models that could be used as a guide in planning instruction for improving speed and power of reading in grades 3 through 6.

CHAPTER II

A REVIEW OF RELATED RESEARCH

Reviews of literature in the field of reading (Holmes, 1948, 1953, 1954a; Johnson, 1949; Gilbert and Holmes, 1955; Bower and Holmes, 1959; Gray, 1960; Singer, 1960; Holmes and Singer, 1964[1]) reveal that no other study has had the specific objectives of the present investigation. However, the following studies are relevant because they are classical studies which preceded the formulation of the substrata-factor theory of reading, or because they are studies from which the hypotheses for this investigation were derived.

These studies cover the range from quantitative measurement of eye-movement behavior in reading as the "most objective symptoms of the central processes" to a theoretical model of the structure and functioning of the substrata-factors underlying speed and power of reading. Buswell (1922) interpreted the developmental curves of eye-movement behavior in reading as general routes to the goal of maturity in reading, around which individuals vary. Using a broader battery of tests, Monroe (1932) concluded from a comparison of good and poor readers at the elementary level that "reading defect may result in those cases in which the number and strength of the impeding factors is greater than the number or strength of the facilitating factors." Lazar (1942) recognized that a method was still needed for "specifically isolating the most significant elements from the combination of many" and for "investigating those causes in their interdependence in order to find out, if possible, which carry the most weight

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[1] This review of the literature (Holmes and Singer, 1964) was undertaken as a part of this project.

...above all, which seem to offer the greatest hope of modifiability." By means of factor analysis and path coefficients, Phelan (1940) was among the first to attempt to quantify the factors, compute their contribution to variance in reading, and construct a model to show their interrelationships. Finally Holmes (1948, 1954) devised the substrata analysis methodology, tested the major hypothesis of the substrata-factor theory of reading, and formally stated the theory (1953).[1] The generalized major hypothesis was subsequently confirmed at the intermediate grade level (Singer, 1960), and known-groups of readers at the high school level were found to call upon different working systems in intragroup competition for attaining speed and power of reading (Holmes and Singer, 1961).

Davis (1963, 1964) extended the generality of the substrata-factor theory of reading by testing the hypothesis that "a significant proportion of interindividual variance in reading rate would be contributed by subsystems within the physiological domain." Using a representative sample of 70 subjects drawn from the California Adolescent Growth Study pool, Davis found through a substrata analysis of five subsystem domains that oxygen transport efficiency accounted for 12.36 per cent and chronological age for 4.12 per cent of variation in speed of reading comprehension, as measured before the eye-movement camera. However, instead of a general domain of physiological efficiency, he found marked specificity. In his group of subjects, rapid reading was associated with nonefficient oxygen transport following exercise, early physiological maturing, accelerated rate of physical development, and low chronological age for actual grade placement. Davis concluded that these results are attributable to a genetic predisposition in interaction with environmental selectivity: individuals with efficient oxygen transport efficiency tend to have higher energy levels and, therefore, given a free choice, are less likely to engage in a sedentary activity such as reading; consequently, they do not get as much practice and hence are not as likely to attain as much fluency in reading as their less energetic peers.

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[1] The theory is implicit in Holmes's 1948 study.

Recently, Kling (1965) concluded from an analysis of 120 ninth graders on nine subject matter variables, in which each variable in turn was used as a major criterion with the remaining variables in the matrix acting as predictors of the variance in the criterion, that "these subject matter systems may qualitatively and quantitatively interact to form a mutually and reciprocally supportive mental cosmos, a suprasystem of functionally related working systems." Kling also pointed out that substrata-factor theory is congruent with general open systems theory.

Several reviews of research on the substrata-factor theory of reading have appeared. Duker (1962) and Brett (1964) found that the conclusions of the high school study (Holmes and Singer, 1961) were consistent with the evidence. Spache (1964a, p. 920) mentioned almost all of the completed research on hypotheses related to the theory, but singled out the fourth grade study (Singer, 1960, 1962) for a more detailed review. Although Spache noted certain limitations, he thought most of the findings at the fourth grade level would meet teacher expectations and concluded that "examination of the implications cannot help but point toward many changes in reading practices, curricula, and remedial techniques." Robinson

(1963, p. 279) mentioned the high school study (Holmes and Singer, 1961) as an example of a "new theoretical framework...which may open up additional avenues of study." Although conceding that the "statistical analysis in Holmes's first experiment (at the college level) was conducted with technical excellence and rigorous standards of research," Plessas (1964, p. 219) nevertheless raised two "major" questions on the relationship between the college level experiment and the theory's psychological model. The first question concerned the validity of the criterion test as a measure of reasoning in reading. The second question pertained to the appropriateness of the variables selected for the predictor battery.[1] Singer (1965d) answered these questions, evaluated all the critiques, and found that the research evidence has accumulated in support of the substrata-factor theory of reading.

The studies by Holmes (1948, 1954), Singer (1960), and Holmes and Singer (1961) will be reviewed in greater detail because hypotheses for this study were based on inferences from the results of these studies.

1. After a comprehensive review of the literature, Holmes (1948, 1954) selected 40 predictors for speed and power of reading. These variables were administered to 126 college students and a cross-validating sample of 94. Then substrata analyses were applied to the resulting correlation matrix to determine which variables made a direct or indirect statistically determined contribution to the variance in speed and power of reading. The results, depicted in the flow chart, Figure 1, show

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[1] Actually, neither of the questions raised by Plessas concerns the theory per se. He was only concerned with instruments used to test hypotheses generated by the theory.

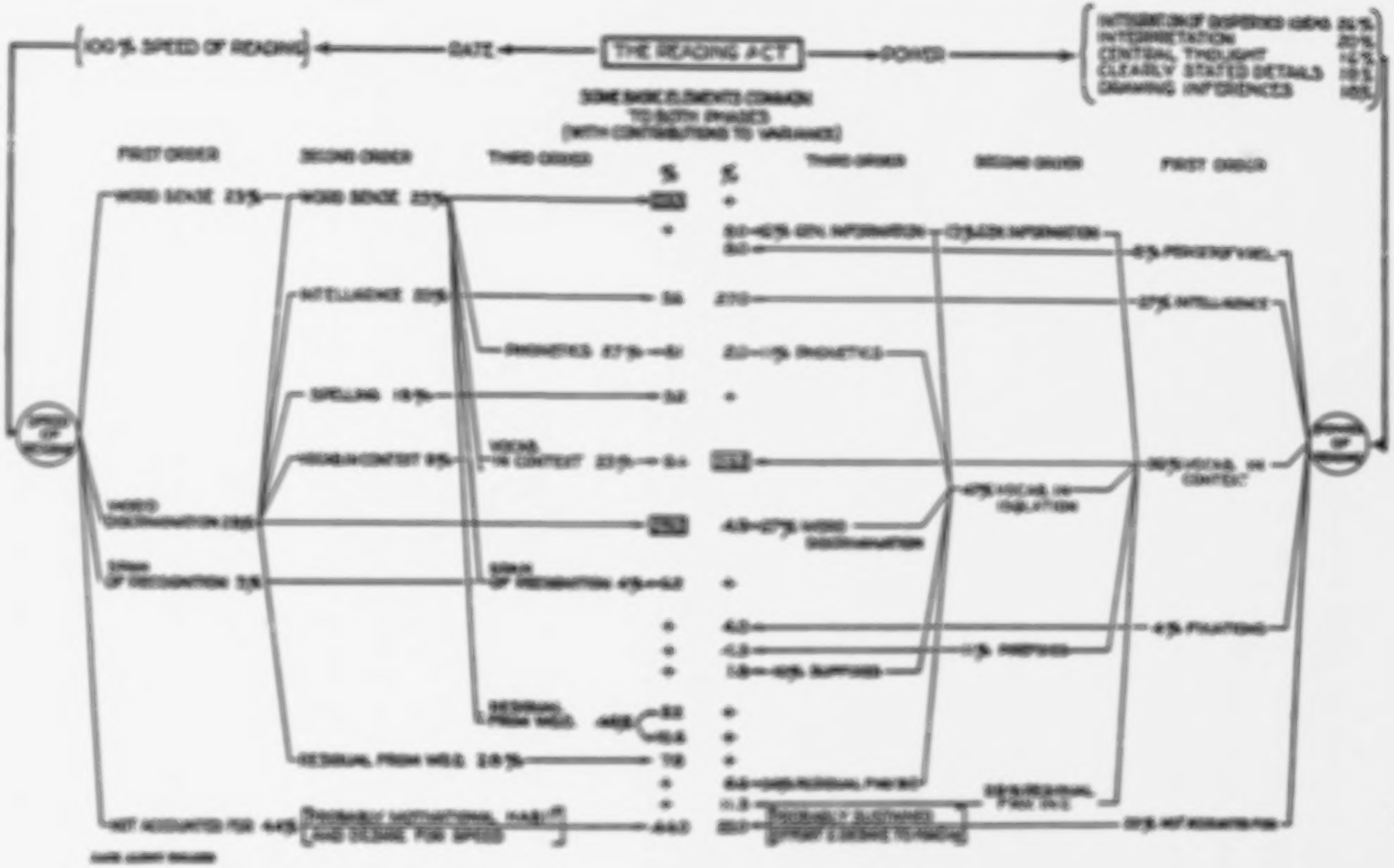

100% SPEED OF READING
RATE
THE READING ACT
POWER
INTEGRATION OF DISPERSED IDEAS
INTERPRETATION
CENTRAL THOUGHT
CLEARLY STATED DETAILS
DRAWING INFERENCES
SOME BASIC ELEMENTS COMMON
TO BOTH PHASES
(WITH CONTRIBUTIONS TO VARIANCE)
FIRST ORDER
SECOND ORDER
THIRD ORDER
%
%
THIRD ORDER
SECOND ORDER
FIRST ORDER
SPEED OF READING
WORD SENSE
WORD SENSE
INTELLIGENCE
PHONETICS
SPELLING
VOCAB. IN CONTEXT
WORD DISCRIMINATION
SPAN OF RECOGNITION
SPAN OF RECOGNITION
RESIDUAL FROM W.D.
RESIDUAL FROM W.S.
NOT ACCOUNTED FOR
PROBABLY MOTIVATIONAL HABIT
AND DESIRE FOR SPEED
GEN. INFORMATION
INFORMATION
INTELLIGENCE
PHONETICS
VOCAB. IN CONTEXT
VOCAB. IN ISOLATION
WORD DISCRIMINATION
FIXATIONS
PREFIXES
SUFFIXES
NOT ACCOUNTED FOR
POWER OF READING

Figure 1--FLOW-SHEET FOR THE TASKS INVOLVED IN THE READING ACT WITH BREAK-DOWN FOR UNDERLYING FACTORS

that seven and ten selected variables underlie Speed and Power of Reading, respectively. Because Speed and Power share four of these variables, the total number is only 13. Selected variables account for 76 per cent of the variance in Power and 36 per cent of the variance in Speed of Reading. The residual or not accounted for variances must be attributable to variables other than those used in this study.

The flow chart, which is a momentary organization of the general working system for college freshmen, shows the relative levels and positions of the selected variables and their direct and indirect contribution to the variance of the subcriteria and to the major criteria, speed and power of reading. The flow chart may be read in various ways to determine how the mind might organize its subskills, ideas, and capabilities to solve a problem in reading. For example, the use of phonetics (right-hand side of the chart, third order) together with general information, word discrimination, and suffixes enter into the constellation of subabilities that make up vocabulary-in-isolation. Vocabulary-in-isolation, plus general information, and prefixes contribute to the variance of vocabulary-in-context. Finally, on the highest level, vocabulary-in-context becomes integrated with perception of verbal relations, intelligence, and magnitude of thought units (fewer fixations/100 words) to culminate in Power of Reading. Again, starting with phonetics, Speed of Reading can similarly be worked out. The number adjacent to each variable gives its per cent contribution to the variance of the predicted subcriterion or criterion.

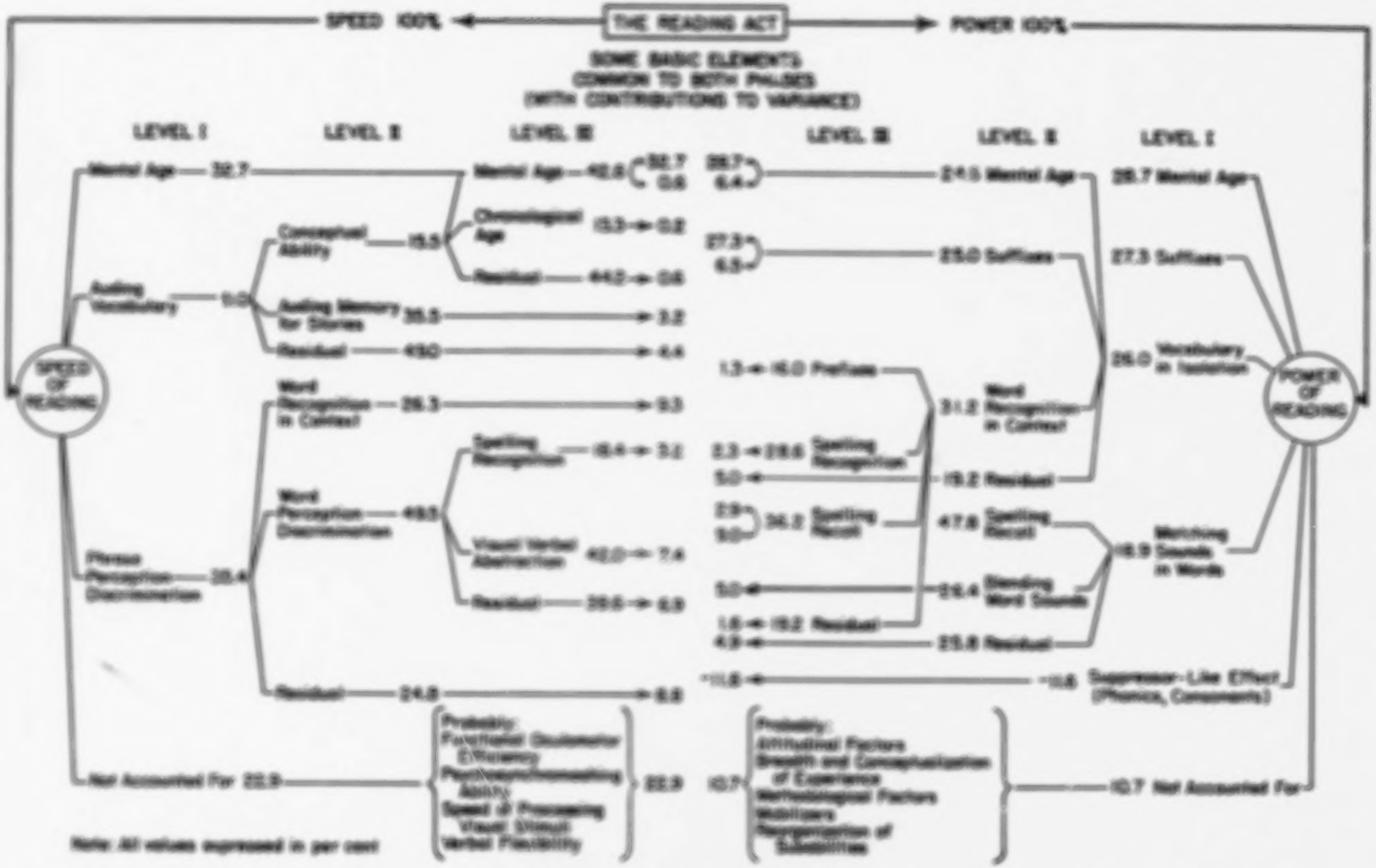
Thus, substrate analyses reduced the general task of reading instruction at the college level from 40 to a minimum of 13 variables.

More important, however, is the resulting theoretical model, depicted in the flow chart, which gives the reading instructor insight into the nature of the structure and dynamics involved in integrating subskills, ideas, and capacities into working systems in accordance with the purposes of the reader and the demands of the tasks.

2. Singer (1960) tested two hypotheses: (1) Whether the generalized major hypothesis of the substrata-factor theory of reading, confirmed at the college level by Holmes (1948, 1954), actually holds at the intermediate grade level: "General reading is a composite of speed and power of reading, and underlying each component is a multiplicity of related and measurable factors. Disabilities in reading, should, therefore, bear an inverse relationship to the quantitative levels of each such component and hence manifest detectable deficiencies in such underlying factors." (2) Whether this hypothesis, derived from a theoretical integration of conceptual ability into the substrata-factor theory of reading, is tenable: A substrata analysis of a matrix of appropriate subskills will precipitate conceptual ability as one of the important subabilities underlying individual differences in speed and/or power of reading.

Substrata-factor and centroid factor analyses of 36 tests administered to 60 fourth graders confirmed both hypotheses. The substrata analyses, shown in Figure 2, yielded a working system of at least three substrata-factor sequences, which may be broadly categorized: word-recognition, word-meaning, and reasoning-in-context. In toto, these account for 77% and 89% of the variance in Speed and Power of Reading, respectively.

Differences within the general working systems for Speed and Power of Reading appear to be related to the difficulty of the reading material


SPEED 100%
THE READING ACT
POWER 100%
SOME BASIC ELEMENTS
COMMON TO BOTH PHASES
(WITH CONTRIBUTIONS TO VARIANCE)
LEVEL I
LEVEL II
LEVEL III
LEVEL III
LEVEL II
LEVEL I
SPEED OF READING
Mental Age — 32.7
Auding Vocabulary — 5.0
Phrase Perception Discrimination — 25.4
Not Accounted For 22.9
Conceptual Ability — 15.5
Auding Memory for Stories 35.5
Residual — 49.0
Word Recognition in Context — 26.3
Word Perception Discrimination — 49.5
Residual — 24.8
Mental Age — 42.6
Chronological Age 13.3
Residual — 44.2
Spelling Recognition — 18.4
Visual Verbal Abstraction 42.0
Residual — 20.6
32.7
0.6
0.2
0.6
3.2
4.4
9.3
3.1
7.4
6.9
8.8
Probably:
Functional Oculomotor Efficiency
Psychoeducational/Associating Ability
Speed of Processing Visual Stimuli
Verbal Flexibility
22.9
28.7
6.4
27.3
6.5
1.3
16.0 Prefixes
2.3
29.6 Spelling Recognition
5.0
2.9
9.0
34.2 Spelling Recall
5.0
1.6
19.2 Residual
4.9
−11.8
10.7
Probably:
Attitudinal Factors
Breadth and Conceptualization of Experience
Methodological Factors
Mobilizers
Reorganization of Subabilities
24.5 Mental Age
25.0 Suffixes
31.2 Word Recognition in Context
19.2 Residual
47.8 Spelling Recall
26.4 Blending Word Sounds
25.8 Residual
−11.8
28.7 Mental Age
27.3 Suffixes
26.0 Vocabulary in Isolation
18.9 Matching Sounds in Words
Suppressor-Like Effect (Phonics, Consonants)
10.7 Not Accounted For
POWER OF READING

Note: All values expressed in per cent

Figure 2—FLOW CHART TO SHOW THE RESULTS OF THE SUBSTRATA ANALYSIS OF SPEED AND POWER OF READING AT THE FOURTH GRADE LEVEL

H. Singer, 1960

and varied purposes of the reader. In both Speed and Power of Reading, a reader brings a complex of ideational processes to bear upon the reading task. When working for speed, a fourth grader tends to mobilize a working system undergirded by the processes of visual word-recognition, concrete and functional concepts, rather than abstract levels of word-meaning. However, when reading for Power, his working system is organized to utilize more auditory word recognition processes, auding, and visual vocabulary abilities. Hence the substrata-factor analyses indicate that a shift in the reading task necessitates a change in the mental organization of the reader; this interpretation is also supported by the pattern of loadings of Speed and Power of Reading on the five interpretable, rotated centroid factors.

3. In a further investigation of the general substrata-factor theory of reading, Holmes and Singer (1961) administered 54 tests to several known-groups (total, boys vs. girls, bright vs. dull, fast vs. slow, and powerful vs. non-powerful), selected from a sample of 400 high school students. Substrata analysis was modified in this study to obtain simple structure by simply eliminating a variable from the pool of predictors once it had been selected, in accordance with the principle of proceeding from more complex to more simple substrata elements.

The results confirmed the hypothesis that there is more than one way to solve an intellectual problem; i.e., different known-groups mobilize different substrata-factor hierarchies for the purpose of reading for Speed and/or Power.

The minor hypothesis, however, was not confirmed. But the accumulated evidence did make it clear how the hypothesis could be made valid. Although a student can bring to focus in the reading process only those skills and abilities in his particular repertoire, he does not tend to integrate into his characteristic hierarchy or working system of substrata-factors those which will maximize the use of his strong abilities and minimize the use of his weak ones--as hypothesized. Instead, a student must first be able to mobilize at least minimum amounts of certain basic audiovisual verbal reasoning abilities, even though these are among his weakest, in order to read for speed and/or power at the high school level. But, as his proficiency increases, he must mobilize into his working system increasing amounts of his appropriate strengths in order to surpass mounting competition, even though these strengths may be only remotely associated with reading success for people in general and may be, in fact, relative weaknesses for his peer group.

The data were also analyzed by centroid factor analysis. Eleven interpretable rotated factors, seven of which were common to all groups, were found. The main loadings of Speed and Power of Reading for all groups were on the audiovisual verbal reasoning factors. However, quantitative and qualitative differences in the results did support the major hypothesis of the study.

In general, the conclusion reached through both centroid and substrata analyses is consistent with the definition that normally, "reading is an audiovisual processing skill of symbolic reasoning, sustained by the interfacilitation of an intricate hierarchy of substrata-factors that have been mobilized as a psychological working system and pressed into service in accordance with the purposes of the reader" (Holmes, 1960).

Comparison of flow charts for the college and intermediate grade level, Figures 1 and 2, suggests the hypothesis that the intermediate grades may be the developmental stage where a transition from an auditory to a visual mode of dominance occurs. Fourth graders mobilize auditory abilities in the first substrata-level of their working system for Power, but not for Speed of reading (Singer, 1960); in contrast, college students do not mobilize auditory perceptual abilities in the first substrata-level of their working system for either Speed or Power of reading (Holmes, 1948, 1954). The substrata analysis test of this hypothesis is that, in general, auditory perceptual abilities will systematically decrease in their contribution(s) to variance in speed and/or power of reading with concomitant increments in reading maturity.

The finding that all readers tend to call upon certain necessary subskills regardless of whether they are strengths or weaknesses in a particular individual's repertoire (Holmes and Singer, 1961) suggests that there is a basic, developmental working system around which individuals vary according to their unique pattern of strengths and weaknesses. Development of general reading ability, therefore, is dependent to some degree upon improvement in these necessary subskills. This study is designed to test this hypothesis and to discover the specific qualitative and quantitative changes in substrata-factors which may accompany development of general reading ability at the upper elementary grade level.

An important by-product of this study is that flow charts will be constructed for each of these grade levels. Hence fundamental knowledge of the nature of development of reading ability will be augmented. This contribution to the field of reading, moreover, is not dependent upon the confirmability of the hypotheses being tested.

CHAPTER III

EXPERIMENTAL DESIGN

The experimental design consists of (a) the selection of a battery of reliable and valid tests for predicting speed and power of reading, (b) administration of this battery to representative samples of pupils in grades 3 through 6, and (c) construction at each grade level of statistically-determined models of substrata-factors for predicting speed and power of reading. The basic assumption of this experimental design is that these statistically-determined models, related according to grade level sequence, constitute developmental models of an average individual's general working system for attaining speed and power of reading in grades 3 through 6.

SELECTION OF TEST BATTERY

A battery of variables which had precipitated as predictors of speed and power of reading in previous investigations at the college (Holmes, 1954), high school (Holmes and Singer, 1961)[1], or elementary school level (Singer, 1960, 1962) were selected for testing the two hypotheses formulated for this investigation. These tests, which could be categorized as measures of mental abilities, listening comprehension, linguistic meaning, word recognition, and visual and auditory perception, were selected after a comprehensive review of the literature (Holmes, 1954;

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[1] An abridged version of the high school study is to be published by the U. S. Office of Education (Holmes and Singer, 1963).

Singer, 1960; Holmes and Singer, 1961) from the batteries of Durrell and Sullivan (1937), Gates (1953, 1958), Holmes (1962b), Kwalwasser and Dykema (1930), Singer (1963), Thurstone and Thurstone (1954), and Van Wagenen (1953). These tests, with modified test names and acronyms, are listed in Table 1.

Because the major developmental hypothesis of this investigation is concerned with the organization of the general working systems for attaining speed and power of reading, an attempt was made to select a comprehensive battery of objective group tests. Personality, interest, and motivational variables, however, were not included in the battery because factors representing these domains either had not precipitated from substrata analyses in previous studies or objective group tests for assessing these domains were not psychometrically suitable for administration in grades 3 through 6. Therefore, the test of the major developmental hypothesis in this study is delimited to changes in the auditory and visual perceptual, linguistic, and cognitive domains sampled by the selected battery of tests.

Of course, personality, interest, and motivational subsystems are related to speed and power of reading, particularly under certain conditions (McDonald, 1960) and for some known-groups (Holmes and Singer, 1961). Indeed, personality variables as "mobilizers" (Holmes, 1959) or determinants of "cognitive style" have been empirically identified for spelling at the college level (Holmes, 1959) and for reading at the junior high school level (Athey, 1965). Consequently, whatever variance in speed or power of reading cannot be accounted for by the selected battery of tests in this study must be attributable to other variables, perhaps to such variables as functional oculomotor efficiency (Gilbert, 1953), flexibility (Laycock, 1958), speed of processing visual stimuli (Gilbert, 1959), as well as

TABLE 1

TEST BATTERY WITH MODIFIED TEST NAMES AND ACRONYMS

Test Battery	Modified Test Name
A. Gates Reading Survey	
1. Speed of Reading	Speed of Reading
2. Level of Comprehension	Power of Reading
B. Thurstone Primary Mental Abilities	
3. Words	Visual Verbal Meaning
4. Pictures	Auditory Picture Meaning
5. Space	Spatial Relations
6. Word Grouping	Visual Verbal Conceptualization
7. Figure Grouping	Reasoning with Visual Figures
8. Perception	Speed of Visual Perception
C. Van Wagenen-Dvorak Silent Reading	
9. Range of Information	Range of Information
D. Durrell-Sullivan Reading Capacity	
10. Word and Paragraph Meaning	Auding
E. Singer Language Perception Tests	
11. Conceptual Ability	Auditory Verbal Conceptualization
12. Prefixes and Suffixes	Meaning of Affixes
13. Word Recognition in Context	Word Recognition in Context
14. Matching Word Sounds	Matching Word Sounds
15. Blending Word Elements	Blending Word Elements
16. Phonics	Phonics
17. Syllabication	Syllabication
18. Auditory Abstraction	Auditory Verbal Abstraction
19. Spelling	Spelling Recognition
20. Word and Phrase Discrimination	Speed of Word Perception
21. Recognition of Affixes and Roots	Recognition of Affixes and Roots
22. Word Reversals	Word Reversals
F. Holmes Language Perception Tests	
23. Word Embedded	Visual Verbal Abstraction
24. Figure and Ground	Dot Figure-Ground Configuration
25. Symbol Closure	Cue-Symbol Closure
G. K-D-H Musical Aptitudes	
26. Pitch Discrimination	Pitch Discrimination
27. Rhythm Discrimination	Rhythm Discrimination
28. Tonal Intensity Discrimination	Tonal Intensity Discrimination

TABLE 1--Continued

TEST BATTERY WITH MODIFIED TEST NAMES AND ACRONYMS

Modified Test Name	Acronym	Time[a]	Items
A. Gates Reading Survey			
1. Speed of Reading	SPEED	7	64
2. Power of Reading	POWER	UT	43
B. Thurstone Primary Mental Abilities			
3. Visual Verbal Meaning	VVMNNG	8	36
4. Auditory Picture Meaning	VPICTR	CT	37
5. Spatial Relations	SPATRL	7	27
6. Visual Verbal Conceptualization	VISCON	6	27
7. Reasoning with Visual Figures	RSNGFG	8	27
8. Perception	PRCPTN	5	50
C. Van Wagenen-Dvorak Silent Reading			
9. Range of Information	RINFOR	CT	40
D. Durrell-Sullivan Reading Capacity			
10. Auding	AUDING	CT	130
E. Singer Language Perception Tests			
11. Auditory Verbal Conceptualization	AUDCON	CT	12
12. Meaning of Affixes	AFFIXS	UT	60
13. Word Recognition in Context	WDRCTX	UT	60
14. Matching Word Sounds	MWDSND	UT	60
15. Blending Word Elements	BLWRDS	CT	50
16. Phonics	PHONIC	UT	55
17. Syllabication	SYLLAB	UT	20
18. Auditory Verbal Abstraction	AUDABS	CT	30
19. Spelling Recognition	SPLREC	UT	70
20. Speed of Word Perception	SPDWRD	6	120
21. Recognition of Affixes and Roots	RAFFRT	UT	60
22. Word Reversals	RVRSLS	3	50
F. Holmes Language Perception Tests			
23. Visual Verbal Abstraction	VVABST	4	40
24. Dot Figure-Ground Configuration	DOTFGD	4	100
25. Cue-Symbol Closure	CUESYC	4	100
G. K-D-K Musical Aptitudes			
26. Pitch Discrimination	PITCHD	CT	40
27. Rhythm Discrimination	RHYTHM	CT	25
28. Tonal Intensity Discrimination	INTNSY	CT	30

[a] Time for speeded tests is given in minutes. CT represents controlled time, in which each pupil had an opportunity to try each item. UT is for untimed tests.

personality, interest, and motivational variables.

The second hypothesis asserts that in addition to other changes in organization of a general working system, there is a gradient-shift in dominance from an auditory to a visual modality as an individual, in general, matures in speed and power of reading. Therefore, variables were also selected for the test battery which would presumably assess input and mediational subsystems in the visual and auditory modalities. Although the selected variables are not "pure" scales for assessing auditory or visual input and mediational subsystems, they seem to have some face validity for such a classification; furthermore, substrata analysis may purify these variables somewhat by partialling out variance from one mode or the other in the process of selecting predictors to account for variance in a criterion variable. Table 2 shows how certain variables in the test battery could, perhaps, be categorized to assess the interrelated auditory and visual input and mediational subsystems (Singer, 1965c).

DESCRIPTION OF TEST BATTERY

Each of the tests in the battery is described below with a brief rationale, procedure for administering the tests, the number of items, and time limits, if any. Following each test's description is a sample item.

TABLE 2

VARIABLES SELECTED FOR ASSESSING INPUT AND MEDIATIONAL PROCESSES IN VISUAL AND AUDITORY MODALITIES

Input Modalities	
Auditory	Visual
Pitch Discrimination	Dot Figure-Ground Configuration
Rhythm Discrimination	Cue-Symbol Closure
Tonal Intensity	Speed of Visual Perception
Input-Mediational Modalities	
Phonics	Spatial Relations
Blending Word Elements	Recognition of Affixes and Roots
Matching Word Sounds	Speed of Word Perception
Auditory Verbal Abstraction	Visual Verbal Abstraction
Mediational Modalities	
Auditory Picture Meaning	Visual Verbal Meaning
Auding	Reasoning with Visual Figures
Auditory Verbal Conceptualization	Visual Verbal Conceptualization

DEPENDENT VARIABLES

A. Gates Reading Survey

1. Speed of Reading. This test consists of 64 short paragraphs of equivalent difficulty, about which the manual (Gates, 1953, p. 3) states:

> ...an average second grade pupil can understand these passages when they are read to him and can read them fairly well on entering the third grade. From this level onward, they represent easy reading.

The purpose of the test is to determine how rapidly a pupil can read relatively easy material of varied content and correctly answer simple questions on the material read. A question for each paragraph asks the pupil to state a simple detail, make an inference, integrate ideas, interpret feelings, predict action, or give the general significance of the paragraph read. Only those paragraphs are credited to which the pupil correctly responds. Because the test measures rate plus comprehension, it could aptly be called "effective rate of reading." Gates (1953, pp. 3-4) has claimed that speed of performance on this test is an index to speed of reading on more complex and various other materials.[1]

The specific instructions to the pupils are to read the paragraph, then circle the word which best answers the question. They are also asked to read and do the exercises as rapidly as they can without making errors. Pupils in all grades were given 7 minutes.

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[1] Correlations between Gates Speed and Van Wagenen Rate of Comprehension on the samples used in this study are .60, .71, .69, and .67 for grades 3 through 6, respectively. This increase in correlations with grade suggests as pupils mature in reading, speed of reading tends to become a general ability which can be tapped by different types of tests. Gates's statement is therefore likely to hold even more at the upper than at the lower grades.

> *Example*: The sun is warm in summer. Boys and girls like to swim and play games on the grass. When do we get very hot days?
>
> winter spring *summer* fall

2. *Level of Comprehension* or *Power of Reading*. This test (Gates, 1958) measures the ability to read and comprehend paragraphs of increasing difficulty when given unlimited time. The test consists of 21 paragraphs with a total of 43 questions. The directions for the test ask the subject to read the paragraph and then underline one of the five words which belongs in the blank space of the paragraph. Consequently, this test is similar to the "cloze" procedure for testing reading comprehension, except that the Gates test provides multiple choices. The pupils are allowed unlimited time to try all paragraphs. The effects of guessing are controlled by means of a correction factor in the scoring procedure.

Gates (1947) has stated that this test is an index of the level of difficulty to which a pupil can read and comprehend.[1] The test seems to call upon a particular kind of analytical power of reading, which includes perception of verbal relations, inferences, integration of ideas, verbal reasoning, or to coin a phrase, the test, in general, might be called a test of "paragraph sense."

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[1] The Gates Level of Comprehension correlates .65, .74, .79, and .78 with the Durrell-Sullivan Reading Achievement Test (Paragraph Meaning) for grades 3 through 6, respectively, on the samples used in this study. The trend of these correlations suggest that comprehension abilities tend to become increasingly integrated as pupils mature in reading ability.

Example: My cat is now very old. After it has had dinner it likes to find a soft, warm __A__ and go to __B__.

A. glass cold bed lake pig

B. town sleep fire swim places

INDEPENDENT VARIABLES

B. Thurstone Primary Mental Abilities. The basic assumption in this test is that intelligence is not unitary, but consists of many components. The abilities assessed on this test are "judged to be of greatest value to educational guidance in the middle elementary grades" (Thurstone and Thurstone, 1954, p. 3).

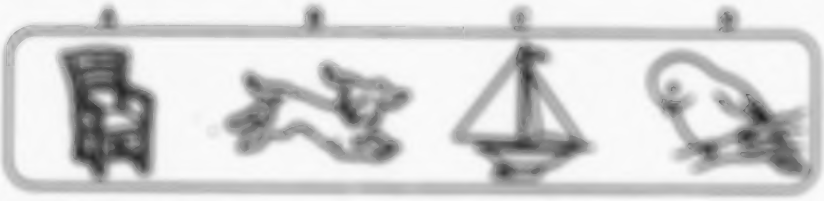
3. Words or Visual Verbal Meaning. This test is a typical multiple choice vocabulary test in which a pupil reads a stimulus word and then has the task of selecting a word with the same meaning from among four choices. The items start at the second grade level and increase in difficulty. The choices in each row are easier or more familiar than the stimulus word. Pupils are given 8 minutes to do the 36 items.

Example: big A. fair B. windy C. soft D. large

4. Pictures or Auditory Picture Meanings. In this test, the examiner reads a word and the children are asked to select a picture from a choice of four that corresponds to the word. Each pupil has an opportunity to respond to each of the 37 items.

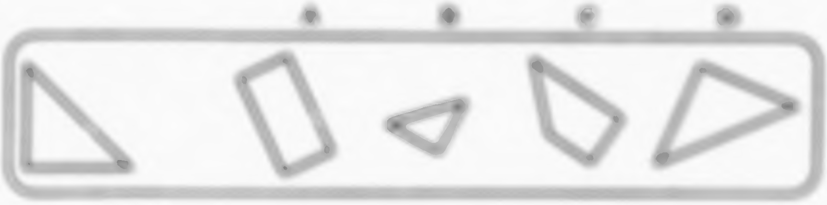
Example: Teacher says: chair

Pupil selects:



5. Space or Spatial Relations. This test measures the ability of an individual to visualize and mentally manipulate two or three geometric designs. The pupil sees the design in one position and dimension and then has the task of selecting a choice of four designs that corresponds to a rotation or dimensional change of the stimulus design. There is a total of 27 items which the pupil can respond to in the seven minutes allowed.

Example:

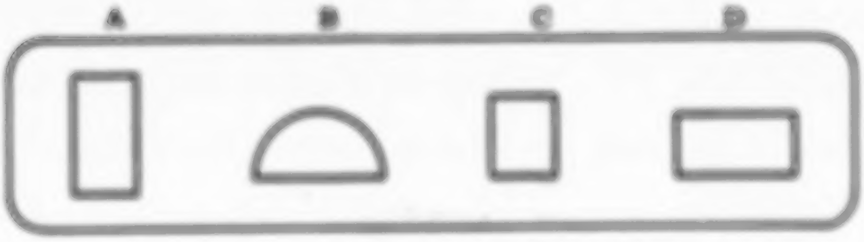


6. Word Grouping or Visual Verbal Conceptualization. In the Word Grouping test the pupil is asked to read and select a word that does not belong in a group of four words. Performance on the 27 word groups is limited to 6 minutes.

Example: A. red B. blue C. heavy D. green

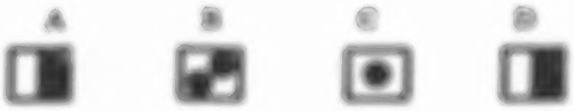
7. Figure Grouping or Reasoning with Visual Figures. Designed as a "non-verbal" analogue to Word Grouping, the Figure Grouping test asks the pupil to find the geometric figure that does not belong with the rest of the group. The pupil has eight minutes for 27 items.

Example:



8. Perception or Speed of Visual Perception. The ability to recognize likenesses or differences between objects or symbols, quickly and accurately, is assessed on Speed of Visual Perception. The assumption is that the ability to scan a page in search of a specific detail depends upon Speed of Visual Perception. For each item, the pupil is asked to select the two identical objects or symbols from among the four given objects or symbols. Exactly five minutes are allowed for the 50 items.

Example:



C. Van Wagenen-Dvorak Diagnostic Examination of Silent Reading Ability.

9. Range of Information. This test consists of 40 questions of information, graded from relatively easy to relatively difficult. Individuals who have developed a broad background of knowledge or apperceptive mass can call upon this background to understand reading material. In general, the greater the individual's apperceptive mass, the more readily the reader can grasp the printed page. This test was modified by having all the questions and choice of answers on the test read to the subject. Hence word recognition ability was minimized as a factor in performance on this test.

Example: The sun rises in the

(1) evening (2) west (3) south (4) morning (5) north

D. *Durrell-Sullivan Reading Capacity Test*.

10. *Word and Paragraph Meaning* or *Auding*. The first part of this test consists of a word read to the subject who then has a choice of eight pictures from which to select to identify the word. There are 70 words which are tested by 14 groups of pictures. The content of this test was based on a random sample of 300 words from the Thorndike vocabulary, and then reduced to 130 that could be pictured. Although the authors attempted to balance the test as to parts of speech, nouns are emphasized because these can be more readily pictured. The second subtest consists of 12 stories that are read to the subjects. After listening to each story the subjects answer five questions on the story by choosing a picture from a set of 3 choices. The content represents factual, informational, science, and history material. Because each item is read to the subjects, they all have the opportunity to respond to each of the 60 questions. The total score possible on the test is 130 items. The basic assumption of the test is that the individual should be able to comprehend the printed word as well as he can the spoken word. However, this reading capacity test has its major loading on a factor that is different from the factor with which reading tests primarily correlate (Singer, 1960, 1965b, 1965c).

E. *Singer Language Perception Tests, Elementary Battery*.

11. *Conceptual Ability* or *Auditory Verbal Conceptualization*. The Conceptual Ability test consists of 12 groups of 10 words per group. In each group of 10 words, four words that are logically related to the same idea occur in a matrix of six other unrelated words. The unrelated words are systematically varied. The words keyed for the concept in a

particular group tend, therefore, to "stand out" as in a figure-ground relationship. The task of the pupil is to determine and check the four words that belong to the same idea. The pupil has to abstract and interrelate the four words; those who are successful may do so by conceiving of an organizing idea. On an *a priori* basis, the intended concepts are concrete (objects, such as airplane), functional (actions or movements, such as jump, hop, skip, gallop), or abstract (ideas, such as communication by letter, phone, newspaper, book).

The test is read to the pupil who also has the words before him and can therefore read along with the tester. This procedure is designed to circumvent word recognition difficulties. Each group of words is read twice. On the first reading, the pupil can formulate the idea and the second time he can check the words related to the idea.

The test of 12 concepts is a *power* test.

Example:	Example Answer Sheet:
1. bat	1. ●
2. bases	2. ●
3. jump	3. ▨
4. punch	4. ▨
5. rocket	5. ▨
6. tulip	6. ▨
7. words	7. ▨
8. look	8. ▨
9. glove	9. ●
10. ball	10. ●

12. *Affixes*: *Prefixes and Suffixes* or *Meaning of Affixes*. The student has the task of looking at a word which contains an underlined prefix and suffix. He is then to choose one of the four choices of phrases that contains the meaning of the underlined affix and to mark his choice on the answer sheet. In each phrase the root word is repeated

along with an additional word or phrase. In one of the choices, the additional word or phrase contains the meaning of the affix. All the affixes in Thorndike (1941) and Stauffer (1942) lists of commonest affixes are lincluded in these tests.

The theory behind this test is that knowledge of affixes may augment word meaning ability by enabling the student to analyze otherwise unknown words. Because the choices require careful comparison, the student also has to employ analytical reasoning ability if he does not already know the general or dictionary meaning of the underlined affix.

The test of 60 items is a power test. Therefore, the pupils are given sufficient time to try each item.

Example: *re*appear.......(1) to appear under (2) to appear again
(3) to appear around (4) to appear real

farm*er*.........(1) a person who works on a farm
(2) a person who is on a farm
(3) a person who is without a farm
(4) a person who is near a farm

13. *Word Recognition in Context*. In this test, the student reads a sentence which has a missing word. The student mentally fills in the missing word by selecting one of four choices that appears under the missing word. These choices are similar in perceptual characteristics: visual (configuration), auditory (homonyms), and phonics (blends, for example). To select the correct word, the reader may draw upon his ability to utilize context clues, spelling, and structural analysis, as well as his reservoir of sight vocabulary. All the words in this test are in the elementary school vocabulary, and most of them are taught in the primary grades, except for the word choices; for these, the reader is expected to

rely upon his word recognition abilities. Utilization of context clues is a feature of this test that does not occur in other tests in this section. Consequently, if a student performs significantly better on this test than on subsequent tests in this section, he is apparently aided by context clues.

The test is a power test. Therefore, all students have an opportunity to try each sentence. The student selects his choice and marks under the proper number on the corresponding row on his answer sheet. No time limit for the 60 items.

Example: He saw the __________fly__________ on the ceiling.
(1) fry (2) dry (3) fly (4) try

14. Matching Word Sounds. On this test, the student sees a stimulus word or phrase and then selects from four choices the matching homonym and marks his choice on the answer sheet. Because homonyms are to be matched, the student must think or vocalize the sound of each of the whole words in the item and then compare the sounds. Because homonyms sound alike but are spelled differently, the student cannot rely upon visual clues alone, but must be able to sound out the whole word or phrase in order to perform well on this test. The student may do his task by sounding out the words vocally, subvocally, or through central auditory processes in communication with visual perception.

The test of 60 items is a power test.

Example: I (1) eye (2) my (3) high (4) ice

15. Blending Word Elements. This test is administered by the teacher who for each item reads the stimulus sound aloud, and then pauses

to give the pupils sufficient time to identify the one word in a row of four word choices which contains the given sound. The student's task is to listen and remember the sound so that he can identify which of four words contains this sound. Hence all pupils have an opportunity to try each item. Choices are marked on the answer sheet.

Each stimulus item read by the teacher is only part of a word. The sounds are those which elementary school children have difficulty in pronouncing and may have difficulty in reading.[1] The test is analogous to the partial aid sometimes given by a teacher to a pupil who cannot recognize a word. Instead of pronouncing the whole word, the teacher pronounces only the difficult part of the word.

In this test, the teacher pronounces the word sound *only once*. Pupils then have to listen attentively; consequently, the testing situation is not interrupted continually by pupils who want the teacher to pronounce the word again. Therefore, each pupil has to hear and remember the stimulus sound, an important aspect of the test.

If the student performs much better on this test than on the phonics test, he exhibits a capability for listening and learning phoneme-grapheme correspondences.

The test is a controlled time test in which the teacher paces each of the 50 items. Pupils are given sufficient time to make a choice and mark the answer sheet.

Example: Teacher says: ark

Pupil selects: (1) sick (2) brook (3) lark (4) mart

---

[1] These sounds are listed in Arthur I. Gates's *Improvement of Reading*, Third Edition, Macmillan, 1947, p. 644.

16. Phonics. This test is designed to measure knowledge of consonant and vowel sounds. The stimulus word contains a particular phonic element, which is indicated by a line under one or two letters. The student reads the word to himself, notes the underlined letter(s), thinks of the sound made in response to these letter(s), and searches for a word among the four choices which contains the same sound, not necessarily indicated by an identical letter, e.g., cat and kit. He then marks his choice on the answer sheet.

The test is a power test. Therefore, there is no time limit for the 55 items.

Example: boy 1. girl 2. toy 3. bat 4. hot 5. none

17. Syllabication. This test measures the ability of the student to syllabify a word consistently. The student draws a line between each syllable. The words represent 10 principles of syllabication and 10 combinations of these principles. Because there are three different words for each principle or combination of principles, a consistency score is derived. The consistency score is the number of times the student formed syllabications correctly on the three words that involved the same principle(s). The assumption is made that consistency is an indication of both knowledge and application of a principle of syllabication. Analysis of each student's test may suggest the principles which the student knows and applies vs. those the student either does not know or does not apply.

The test which has a total score possible of 20 consistent applications of syllabication principles is a power test.

Example: 1. berries 27. balloon 53. penny

18. *Auditory Abstraction* (Embedded Sound) or *Auditory Verbal Abstraction*. In this test, the tester reads each word in a row of four words to the student. A common sound can be heard in all four words. The student's task is to listen and abstract the *longest* common sound and then to identify the letters that make this common sound. Only the fourth word is printed on the student's paper. Therefore, he has to rely upon auditory abstraction to perform well on this test. The student indicates his answer by circling the letters that represent the *longest* common sound he has heard in all four words.

The theory behind this test is that individuals may reduce the phonic complexity of the language by organizing visually dissimilar letters according to common auditory elements. Individuals who are successful in this approach to learning to read therefore have a relatively easier task than the individuals who try to form an auditory category for each different set of visual symbols or try to establish a separate category for each phoneme-grapheme relationship. The test has 30 items.

Example:	Teacher says:			Subject circles:
	came	tame	blame	s $\boxed{\text{a m e}}$

19. *Spelling* or *Spelling Recognition*. The student sees four different spellings for a word, one of which is correct. He decides which word is correct and marks his choice on the answer sheet.

The words are a sample from grades 2 through 8 from the *California Word Mastery Spelling Manual* (Patton, 1951) and from the high school form of the Language Perception Tests (Holmes, 1962). Therefore, the test can measure a wide range of spelling recognition ability.

The test is intended as a *power* test. Hence, all students are given an opportunity to try all of the 70 items on the test.

Example: (1) cet (2) kat (3) cat (4) cit

20. *Word and Phrase Discrimination* or *Speed of Word Perception*. In this test both word and phrase discrimination are combined. In Word Discrimination the student sees a word and has to find the *identical* word from among three similar appearing words. Individuals who can rapidly perceive and retain a whole word will tend to obtain a higher score than a person who has a slower and narrower span of perception.

In Phrase Discrimination, the student sees a phrase of two words and has to find the identical phrase from among three similar appearing phrases. Individuals who have a broad span of perception and good oculomotor control will tend to obtain a higher score than a person who has a narrower span of perception or poorer oculomotor control. The time limit is set so that only the fastest word and phrase perceiver in the sixth grade is likely to approach completion of the test. Thus the test measures speed and span of word perception and therefore may be a paper-and-pencil analogue to Gilbert's (1953) measure of functional oculomotor efficiency. After the student selects the identical word or phrase, he is to mark under its number on the answer sheet in the corresponding row. Time limit for the 120 items is 6 minutes.

Examples: A. man (1) can (2) man (3) mar (4) ran
B. right there (1) right here (2) write there [✓ (3) right there]

21. *Recognition of Affixes and Roots*. The student is to find the longest prefix, suffix, or root embedded among nonsense letters. He sees the word and then has a choice of four ways of underlining this combination of letters to show the longest prefix, suffix, or root contained in this combination of letters. The student marks his choice on an answer sheet.

The rationale behind this test is that although the student may not have been taught the specific prefixes, suffixes, or roots used in the test, he may have learned to recognize these aspects of language from their recurrence in oral and written communication. If the student has learned to perceive these familiar letter combinations in print, then he has acquired the necessary foundation for learning their meaning.

This test of 60 items is a *power* test.

Example: *re*qyr oz*mot*qiq qtzp*able*

22. *Word Reversals*. The subject has the task of looking at a stimulus word and thinking of what the letters in this stimulus word would look like when they are reversed or spelled backwards, e.g., "saw" and "was." In perceiving or searching for the reversed word, the subject has a choice of four words, one of which is the correctly reversed word. The other choices have a characteristic reversal letter, e.g., "b" for "d." The student who has difficulty in speed of perceptual control will tend to make more errors than the subject who has good perceptual control. After the subject has made his choice for the reversed word, he is to mark under the number of his choice in the corresponding row on his answer sheet. Time limit is 3 minutes for 50 items.

Example: on.....(1) ou (2) no (3) uo (4) mo

F. Holmes Language Perception Tests, High School and College Battery.

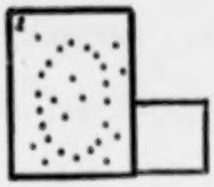
23. Word Embedded or Visual Verbal Abstraction. The Word Embedded test samples the student's ability to perceive and abstract quickly a common word against a background of distracting elements. An easy or familiar word is hidden in a surrounding pattern of letter combinations. Four groups of such patterns are presented for a given word, which is a very familiar English word. The student must perceive the longest word common to all four groups or patterns of letters. After the student has perceived this familiar word, he writes the word on his answer sheet. The hypothesis behind this test is that an individual may simplify the acquisition of responses to redundant visual verbal stimuli by a process of abstraction and concept formation. The products of this process are mediational responses that can then be utilized in word recognition for identical elements, either for identical structural elements, such as blends (train, try, treat) or syllables, or for meaningful elements, such as affixes, roots, and word variants. This test is a visual equivalent to Auditory Verbal Abstraction. Time limit is 4 minutes for 40 items.

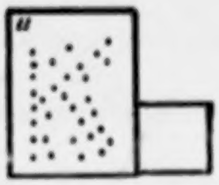
Example: abuse erbus busee abuso __bus__

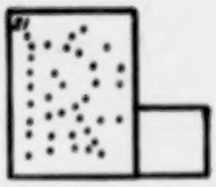
24. Figure and Ground or Dot Figure-Ground Configuration. This test assesses the student's ability to perceive rapidly the suggested outline of a letter hidden in a distracting or random pattern of scattered dots. The figures to be identified are of varying sizes and styles. The test seems to measure speed of closure under minimum conditions of visual

perception. It is similar to the test that Thurstone (1944) found was related to speed of reading. If the student has visual perceptual difficulties, he may not perform well on this test. After the student perceives the letter or number, he writes it in a box adjacent to the item. The time limit is 4 minutes for 100 items.

Example:

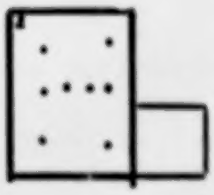


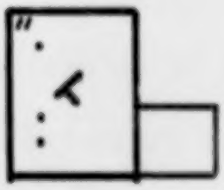


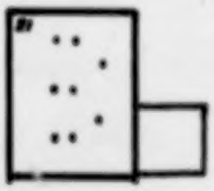


25. Symbol Closure or Cue-Symbol Closure. This test measures the ability to conceive of a familiar letter or number that is suggested by a limited number of visual cues, consisting of lines or dots in incomplete patterns without distracting background. The student draws the figure in a box adjacent to the item. Because the distracting dots of the Figure and Ground test are not present, a better performance on Symbol Closure than on Figure and Ground may arouse suspicion of peripheral visual difficulty. The hypothesis behind this test is that speed of reading is dependent to some degree upon the ability to quickly perceive a whole word from its parts or to build up a word from a minimum of visual perceptual cues. Time limit is 4 minutes for 100 items.

Example:







G. Kwalwasser-Dykema-Holmes Musical Aptitudes Test. These tests are measures of auditory abilities. Because language and reading instruction utilize a variety of auditory elements, such functions may be determiners of achievement in reading, particularly for such subskills as phonics, matching word sounds, syllabication, auditory verbal abstraction, and other skills which all depend upon abilities in the auditory modality.

The directions are read to the subject, but the test itself is presented by playing a record. The test was modified by Holmes (1954b) to increase its reliability, primarily by giving individuals a third choice for each item. Where the original choice consisted, for example, of determining whether the pitch of a note has gone "up" or "down," another choice was added of "same." Only the following three subtests were sufficiently reliable for inclusion in the study:

26. Pitch Discrimination. The subject hears a tone for three seconds and decides whether the tone remains the same, goes up, or goes down. There are 40 items in this test, which tend to increase in difficulty. A sample item is played to the subject.

27. Rhythm Discrimination. Pairs of rhythmic patterns are played. The subject decides whether the pairs are the same or different. Differences may be either in time or intensity variation. There are 25 items on the test, which increase in difficulty, primarily because of an increase in the number of tones.

28. Tonal Intensity Discrimination. The subject hears a group of three tones or chords. His task is to decide whether the middle tone or chord is equal in loudness, stronger, or weaker than the first tone or chord. There are 30 items on the test.

SAMPLE

The tests were administered to all pupils in grades 3 through 6 in six elementary schools located in an average socio-economic district in Alvord, California. A total of 927 pupils in these grades took the entire test battery. As shown in Table 3, the mean scores of the grade level samples on Chronological Age, Primary Mental Abilities I.Q. and Gates Reading Survey Speed of Reading approximate the standardized test norms. But, on Level of Comprehension or Power of Reading, the samples on the average remain approximately 3.5 points below the norm. On the other variables, however, the grade level samples appear to be representative of the general population of pupils in grades 3 through 6.

Although a selective migrational factor may be present in the California school population, the fact that this population has come from all over the United States means that the results of this study cannot be attributed to any particular method of instruction nor to any one set of reading materials.[1] Instead, the results of this study must be related to a general method of instruction and to a general set of materials because many of the pupils in this study had at least some of their reading instruction in schools located throughout the country and consequently had been exposed to a wide variety of instructional techniques and materials.

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[1] Teachers identified out of the total sample only 80 pupils who came from bilingual homes. However, within grade comparisons between these children and their peers from monolingual homes revealed no differences in Speed and Power of Reading that were statistically significant at the five per cent level of confidence. These results are not surprising since even immigrant children who have attended elementary school in this country for three or four years demonstrated that their vocabulary ability approached their mental age on the Stanford-Binet at the end of the sixth grade (Singer, 1956).

TABLE 3

COMPARISON OF CERTAIN SAMPLE MEANS WITH STANDARDIZED TEST NORMS

Grade	Variable	Sample Size	Sample Mean	Standardized Test Norms
3	Chronological Age	223	9-0	9-0
	PMA Intelligence Quotient		101	100
	Gates Speed of Reading		15.4	14.2
	Gates Level of Comprehension		9.6	13.1
4	Chronological Age	283	9-11	10-0
	PMA Intelligence Quotient		102	100
	Gates Speed of Reading		19.9	18.7
	Gates Level of Comprehension		15.6	18.0
5	Chronological Age	262	10-11	11.0
	PMA Intelligence Quotient		99	100
	Gates Speed of Reading		22.1	23.5
	Gates Level of Comprehension		19.5	24.0
6	Chronological Age	159	12-0	12-0
	PMA Intelligence Quotient		97	100
	Gates Speed of Reading		28.9	27.9
	Gates Level of Comprehension		23.3	26.6

PSYCHOMETRIC CHARACTERISTICS OF THE TESTS

The data for the mean raw scores and standard deviations on each variable for grades 3 through 6 are given in Table 4. All the tests for differences between means for adjacent grades in this table are statistically significant at least at the five per cent level. These results indicate that these scales can adequately measure development in all the variables that were selected as potential substrata-factor predictors of speed and power of reading in grades 3 through 6.

Also, curricular validity for the tests can be inferred from the mean increments in test scores from grade to grade. For such comparisons of variables within grade and between grades, the test data on each variable for all 927 pupils in grades 3 through 6 were transformed into standard scores with a mean of 50 and a standard deviation of 10. Then, for each grade level, the mean standard score on each variable was computed. These resulting mean standard scores are shown in Table 5. The plotted profiles of these mean standard scores for grades 3 through 6 are visually depicted in Figure 3. As shown in this figure, the mean standard scores of all the variables increase in more or less uniform increments from grade to grade. Such development in all the variables may be attributable to a comprehensive instructional program interacting with a general linear rate of mental development and some degree of intercortical facilitation (Singer, 1964a). Moreover, these mean increments indicate that the quantitative part of the hypothesis tested in this study should be confirmed: development in speed and power of reading in the average reader is accompanied by increases in the magnitude of substrata-factors.

Table 4

Raw Score Means and Standard Deviations, Grades 3 Through 6

No.	Name	Means				Standard Deviations			
	Dependent Variables	Gr.3	Gr.4	Gr.5	Gr.6	Gr.3	Gr.4	Gr.5	Gr.6
01	Speed of Reading	15.4	19.9	22.1	28.9	6.9	7.6	8.5	11.4
02	Power of Reading	9.6	15.6	19.5	23.3	6.9	8.1	8.9	9.4
	Independent Variables								
03	Visual Verbal Meaning	12.9	18.4	22.7	27.1	6.0	7.2	7.5	7.2
04	Auditory Picture Meaning	15.4	19.7	22.7	26.1	4.2	5.1	5.4	6.3
05	Spatial Relations	14.3	15.8	17.4	18.4	4.4	4.3	4.0	3.9
06	Visual Verbal Conceptualization	13.3	17.1	18.6	20.2	5.2	4.8	4.5	4.3
07	Reasoning with Visual Figures	15.3	18.0	19.3	20.4	4.9	4.2	3.6	3.4
08	Speed of Visual Perception	17.6	23.4	24.8	29.9	6.9	7.8	8.5	7.8
09	Range of Information	16.9	20.4	24.0	26.9	4.7	5.1	5.4	5.6
10	Auding	70.1	84.4	92.2	97.0	14.6	15.4	13.3	13.9
11	Auditory Verbal Conceptualization	4.9	6.5	7.3	7.8	3.2	2.9	2.7	3.0
12	Meaning of Affixes	16.7	23.1	28.1	34.0	6.8	8.8	9.6	10.1
13	Word Recognition in Context	30.9	41.1	44.3	48.9	14.8	13.8	13.3	11.8
14	Matching Word Sounds	28.7	39.6	44.1	49.2	14.9	15.2	14.0	12.0
15	Blending Word Elements	26.1	31.9	33.3	35.5	8.8	8.0	7.6	7.5
16	Phonics	14.9	21.9	26.9	30.9	8.7	12.3	12.2	12.7
17	Syllabication	3.2	5.0	6.1	7.5	2.5	3.2	3.7	3.6
18	Auditory Verbal Abstraction	10.8	14.1	15.2	17.5	6.5	6.2	5.9	5.5
19	Spelling Recognition	29.4	38.0	42.8	49.7	10.8	11.8	11.7	11.9
20	Speed of Word Perception	27.8	36.8	43.2	52.9	9.4	13.1	12.6	15.6
21	Recognition of Affixes and Roots	18.1	25.4	30.1	35.2	9.3	9.9	9.4	8.6
22	Word Reversals	8.1	11.5	14.6	18.2	5.8	6.6	7.2	8.9
23	Visual Verbal Abstraction	9.6	15.0	19.5	22.5	6.1	7.1	8.7	8.4
24	Dot-Figure Ground Configuration	47.9	51.5	54.5	58.9	10.5	11.5	11.3	11.0
25	Cue-Symbol Closure	22.9	26.2	30.1	34.9	7.9	8.6	9.1	9.5
26	Pitch Discrimination	15.4	17.0	18.6	20.3	4.3	5.6	5.0	5.2
27	Rhythm Discrimination	15.0	16.1	17.2	18.5	3.4	3.1	2.7	2.7
28	Tonal Intensity Discrimination	13.0	14.6	15.9	16.7	4.3	4.0	3.0	3.0

TABLE 5

MEAN STANDARD SCORES FOR GRADES 3, 4, 5 & 6[a]

No.	Name	Grade 3	Grade 4	Grade 5	Grade 6
Dependent Variables					
01	SPEED	44.1	48.9 **	51.2 **	58.3 **
02	POWER	42.7	49.0 **	53.0 **	57.0 **
Independent Variables					
03	VVMNNG	41.9	48.4 **	53.4 **	58.6 **
04	VPICTR	41.8	48.6 **	53.3 **	58.6 **
05	SPATRL	45.5	48.7 **	52.5 **	54.6 *
06	VISCON	42.8	49.9 **	52.7 **	55.7 **
07	RSNGFG	43.8	49.7 **	52.6 **	55.1 **
08	PRCPTN	43.2	49.9 **	51.4	57.3 **
09	RINFOR	42.3	47.9 **	53.6 **	58.3 **
10	AUDING	41.2	49.4 **	54.0 **	56.8 **
11	AUDCON	44.6	49.7 **	52.4 **	54.0
12	AFFIXS	42.3	48.4 **	53.1 **	58.6 **
13	WDRCTX	43.3	50.2 **	52.3 **	55.4 **
14	MWDSND	42.9	49.8 **	52.6 **	55.8 **
15	BLWRDS	43.8	50.4 **	52.1 *	54.6 **
16	PHONIC	43.6	49.0 **	52.9 **	56.0 **
17	SYLLAB	44.2	49.2 **	52.1 **	56.1 **
18	AUDABS	44.8	49.8 **	51.6 *	55.0 **
19	SPLREC	42.6	49.0 **	52.6 **	57.8 **
20	SPDWRD	42.4	48.4 **	52.6 **	59.0 **
21	RAFFRT	42.3	48.8 **	53.1 **	57.8 **
22	RVRSLS	44.1	48.4 **	52.4 **	57.0 **
23	VVABST	42.5	48.6 **	53.7 **	57.0 **
24	DOTFGD	45.8	48.9 **	51.5 **	55.2 **
25	CUESYC	44.7	48.1 **	52.2 **	57.1 **
26	PITCHD	45.8	48.8 **	51.9 **	55.0 **
27	RHYTHM	45.1	48.6 **	52.0 **	55.8 **
28	INTNST	44.9	49.2 **	52.4 **	54.6 **

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[a] The scores were standardized with a mean of 50 and a standard deviation of 10 on the total sample of 927 pupils. Then the mean standard scores for each grade were computed. All differences in mean standard scores for adjacent grades (Grade 3 vs. 4, 4 vs. 5, 5 vs. 6) are statistically significant at the one per cent level, except the scores marked with one or no asterisk. The latter are significantly different from the adjacent lower grade at only the five and ten per cent level, respectively.

No.	Name
	Dependent Variables
01	Speed of Reading
02	Power of Reading
	Independent Variables
03	Visual Verbal Meaning
04	Auditory Picture Meaning
05	Spatial Relations
06	Visual Verbal Conceptualization
07	Reasoning with Visual Figures
08	Speed of Visual Perception
09	Range of Information
10	Auding
11	Auditory Verbal Conceptualization
12	Meaning of Affixes
13	Word Recognition in Context
14	Matching Word Sounds
15	Blending Word Elements
16	Phonics
17	Syllabication
18	Auditory Verbal Abstraction
19	Spelling Recognition
20	Speed of Word Perception
21	Recognition of Affixes and Roots
22	Word Reversals
23	Visual Verbal Abstraction
24	Dot Figure-Ground Configuration
25	Cue-Symbol Closure
26	Pitch Discrimination
27	Rhythm Discrimination
28	Tonal Intensity Discrimination

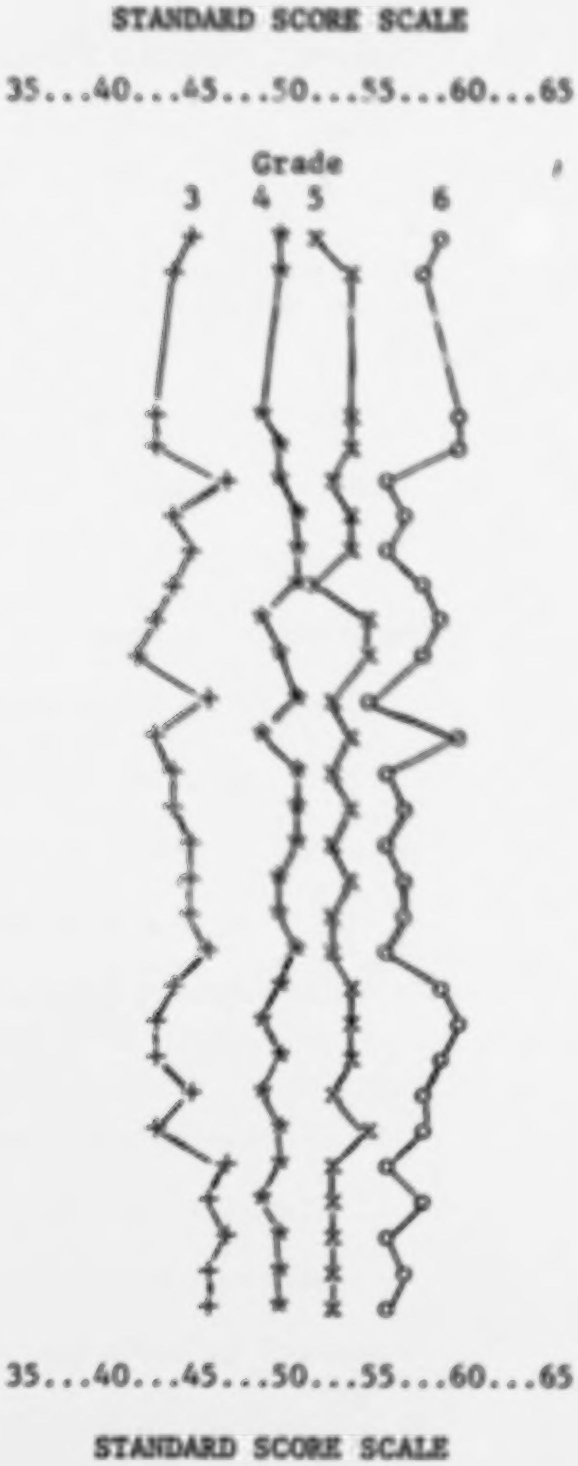

Figure 3. Psychograph of Mean Standard Scores for Grades 3, 4, 5, and 6. All differences between mean standard scores are significant at the five per cent level, except for Speed of Visual Perception between grades 4 and 5 and Auditory Verbal Conceptualization between grades 5 and 6.

The reliabilities of the tests are listed in Table 6. These reliabilities are split-half, corrected by Spearman-Brown Prophecy formula for the untimed tests, and parallel scale reliabilities for the timed tests.

Tables 7 and 8 show the concurrent validity coefficients of the experimentally independent variables with Speed and Power of Reading. These coefficients vary gradually from a correlation of -.05 for Tonal Intensity Discrimination at the third grade to .74 for Visual Verbal Meaning at the sixth grade with Speed of Reading and from .03 for Cue Symbol Closure at the third grade to .83 for Visual Verbal Meaning at the sixth grade with Power of Reading. This finely graduated array of validity coefficients attests to the wide variety of functions measured by the test battery and to the necessity for higher-order statistical methods of analysis to determine the minimum number of variables in a linear prediction equation that would tend to yield a maximum prediction of Speed and Power of Reading.

Because a multiple regression equation assumes rectilinearity in the bivariate relationship between each predictor in the regression equation with the criterion measure, both rectilinear and curvilinear coefficients were computed between each variable and Speed of Reading and between each variable and Power of Reading at each grade level.[1] A chi-square test for each resulting pair of bivariate relationships revealed no statistically significant differences. Therefore, the standard

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[1] These results are shown in Tables M and N in the Appendix. Computations were performed on the IBM 7090 Computer at the University of California, Berkeley by means of RSCAT program written by M. Maruyama.

TABLE 6

TEST BATTERY RELIABILITY COEFFICIENTS FOR GRADES 3 THROUGH 6[a]

No.	Name	Gr. 3 N =50	Gr. 4 N =50	Gr. 5 N =50	Gr. 6 N =50
	Dependent Variables				
01	Speed of Reading	.96	.88	.91	.89
02	Power of Reading	.84	.89	.88	.90
	Independent Variables				
03	Visual Verbal Meaning	.90	.91	.94	.93
04	Auditory Picture Meaning	.66	.70	.88	.89
05	Spatial Relations	.82	.83	.84	.74
06	Visual Verbal Conceptualization	.84	.79	.85	.78
07	Reasoning with Visual Figures	.80	.84	.63	.59
08	Speed of Visual Perception	.88	.94	.93	.91
09	Range of Information	.81	.73	.77	.81
10	Auding	.88	.92	.91	.92
11	Auditory Verbal Conceptualization	.77	.76	.82	.90
12	Meaning of Affixes	.65	.87	.89	.92
13	Word Recognition in Context	.95	.93	.93	.96
14	Matching Word Sounds	.95	.96	.95	.97
15	Blending Word Elements	.88	.85	.80	.93
16	Phonics	.86	.96	.93	.96
17	Syllabication	.74	.83	.74	.86
18	Auditory Verbal Abstraction	.91	.90	.86	.85
19	Spelling Recognition	.91	.90	.92	.95
20	Speed of Word Perception	.87	.80	.84	.80
21	Recognition of Affixes and Roots	.89	.89	.88	.89
22	Word Reversals	.64	.73	.71	.82
23	Visual Verbal Abstraction	.85	.81	.81	.82
24	Dot-Figure Ground Configuration	.73	.75	.53	.60
25	Cue-Symbol Closure	.71	.65	.68	.56
26	Pitch Discrimination	.44	.73	.65	.67
27	Rhythm Discrimination	.79	.64	.64	.61
28	Tonal Intensity Discrimination	.62	.82	.81	.50

[a] A random sample of 25 boys and 25 girls from each grade level was used in the reliability study.

TABLE 7

CONCURRENT VALIDITY COEFFICIENTS
FOR SPEED OF READING
IN GRADES 3 TO 6

No.	Name	SPEED OF READING			
	Dependent Variables	Gr.3	Gr.4	Gr.5	Gr.6
01	Speed of Reading	---	---	---	---
02	Power of Reading	.43	.60	.61	.72
	Independent Variables				
03	Visual Verbal Meaning	.53	.63	.64	.74
04	Auditory Picture Meaning	.26	.46	.47	.60
05	Spatial Relations	.18	.09	.13	.27
06	Visual Verbal Conceptualization	.40	.49	.49	.56
07	Reasoning with Visual Figures	.16	.17	.15	.39
08	Speed of Visual Perception	.26	.28	.31	.39
09	Range of Information	.30	.48	.52	.61
10	Auding	.27	.42	.38	.57
11	*Auditory Verbal Conceptualization*	*.43*	*.42*	*.43*	*.52*
12	Meaning of Affixes	.45	.64	.63	.74
13	Word Recognition in Context	.44	.52	.57	.60
14	Matching Word Sounds	.49	.55	.61	.68
15	Blending Word Elements	.33	.51	.52	.61
16	Phonics	.37	.53	.50	.61
17	Syllabication	.38	.48	.39	.53
18	Auditory Verbal Abstraction	.35	.45	.35	.59
19	Spelling Recognition	.55	.63	.66	.73
20	Speed of Word Perception	.58	.58	.55	.66
21	Recognition of Affixes and Roots	.47	.40	.37	.54
22	Word Reversals	.15	.33	.47	.59
23	Visual Verbal Abstraction	.45	.45	.42	.47
24	Dot Figure-Ground Configuration	.22	.22	.27	.31
25	Cue-Symbol Closure	.17	.27	.24	.36
26	Pitch Discrimination	.17	.24	.16	.25
27	Rhythm Discrimination	-.02	.19	.16	.14
28	Tonal Intensity Discrimination	-.05	.20	.24	.33

TABLE 8

CONCURRENT VALIDITY COEFFICIENTS
FOR POWER OF READING
IN GRADES 3 TO 6

No.	Name	POWER OF READING			
Dependent Variables		Gr.3	Gr.4	Gr.5	Gr.6
01	Speed of Reading	.43	.60	.61	.72
02	Power of Reading	---	---	---	---
Independent Variables					
03	Visual Verbal Meaning	.68	.75	.74	.83
04	Auditory Picture Meaning	.41	.49	.61	.57
05	Spatial Relations	.41	.30	.27	.35
06	Visual Verbal Conceptualization	.66	.67	.64	.68
07	Reasoning with Visual Figures	.37	.31	.27	.42
08	Speed of Visual Perception	.34	.30	.20	.32
09	Range of Information	.54	.56	.60	.64
10	Auding	.47	.51	.54	.60
11	Auditory Verbal Conceptualization	.63	.58	.59	.58
12	Meaning of Affixes	.50	.74	.76	.78
13	Word Recognition in Context	.72	.70	.69	.71
14	Matching Word Sounds	.69	.75	.70	.78
15	Blending Word Elements	.65	.68	.66	.66
16	Phonics	.55	.63	.64	.66
17	Syllabication	.54	.59	.46	.57
18	Auditory Verbal Abstraction	.60	.59	.50	.57
19	Spelling Recognition	.68	.68	.65	.72
20	Speed of Word Perception	.45	.47	.34	.51
21	Recognition of Affixes and Roots	.53	.53	.37	.57
22	Word Reversals	.39	.46	.44	.53
23	Visual Verbal Abstraction	.49	.44	.34	.42
24	Dot Figure-Ground Configuration	.03	.02	.14	.19
25	Cue-Symbol Closure	.03	.18	.16	.31
26	Pitch Discrimination	.24	.26	.16	.23
27	Rhythm Discrimination	.21	.25	.21	.12
28	Tonal Intensity Discrimination	.16	.21	.26	.35

error of estimate of each regression equation in this study for the first level predictors of Speed or Power of Reading will be uniform throughout the range of prediction (Mosier, 1951).

Thus, the psychometric characteristics of the test data indicate that these data can be suitably utilized in multiple correlation analysis. The next chapter explains substrata analysis, the method of analysis used in this study, which is a methodological extension of multiple correlation.

CHAPTER IV

SUBSTRATA ANALYSIS METHODOLOGY

Substrata analysis consists of an extension (Holmes, 1948) and modification (Holmes and Singer, 1961) of the Wherry-Doolittle Multiple Test Selection Technique (Wherry, 1947). This technique tends to select the minimum number of variables from a correlation matrix that yields a maximal prediction of a criterion. The resulting submatrix is next inverted to obtain a multiple regression equation and the components of this equation are corrected for "shrinkage" or accumulative bias that results from systematic selection of variables. This correction then yields a better estimate of the multiple correlation that would be obtained in a subsequent cross-validation in which the same select variables were used to predict the same criterion in another sample drawn from the same population. The per cent contribution made by each predictor to the variance of the criterion is then computed from this corrected multiple regression equation. Since it is theoretically possible to account for all the variance in the criterion, the unpredicted or remaining per cent variance in the criterion must then be attributable to variables other than those used in the pool of predictors or the correlation matrix from which the submatrix had been selected.

Holmes (1948) extended the technique to analyze the variance of each predictor that could be psychoeducationally analyzed from the remaining pool of predictors by eliminating the major criterion and finding which of the remaining variables in the correlation matrix are substrata-factors for each predictor or subcriterion. Subsequent modifications (Holmes and Singer, 1961) led to (a) the use of an F-test (McNemar, 1955) to determine the number of significant variables to select at any one level or for any one subcriterion and (b) the development of simple structure in the working system by systematically eliminating a variable from subsequent predictor matrices in the substrata analysis once it had been selected, in accordance with the methodological assumption that this systematic elimination procedure permitted the analysis of the general working system for attaining speed and power of reading to proceed from the more closely and directly related to the more remotely and indirectly related substrata levels. Substrata analysis was thus carried out to three levels in this study to obtain a best estimate of the organization of abilities and capacities that accompany development in Speed and Power of Reading for the average individual in grades 3 through 6. Comparison of the resulting organization of the general working system across these grade levels was then made to determine whether or not there are systematic qualitative or quantitative changes in abilities and capacities that are concomitant with improvement in Speed and Power of Reading.

Simple structure substrata analysis is schematically depicted in Figure 4a. The figure is to be read in the following way: C_0 is the Level 0 or major criterion that has been predicted, which in this study would be Speed or Power of Reading. The Level I predictors or substrata-factors, P_{01} through P_{0m}, precipitated from the correlation matrices as predictors of the major criterion. Each of these predictors had accounted for some of the variance in the major criterion over and above that accounted for by the first predictor, according to the F-test of significance. Predictors were thus selected from the correlation matrix until the selection of another predictor would not contribute at the one per cent level of confidence in a test of significance beyond what had been accounted for by the

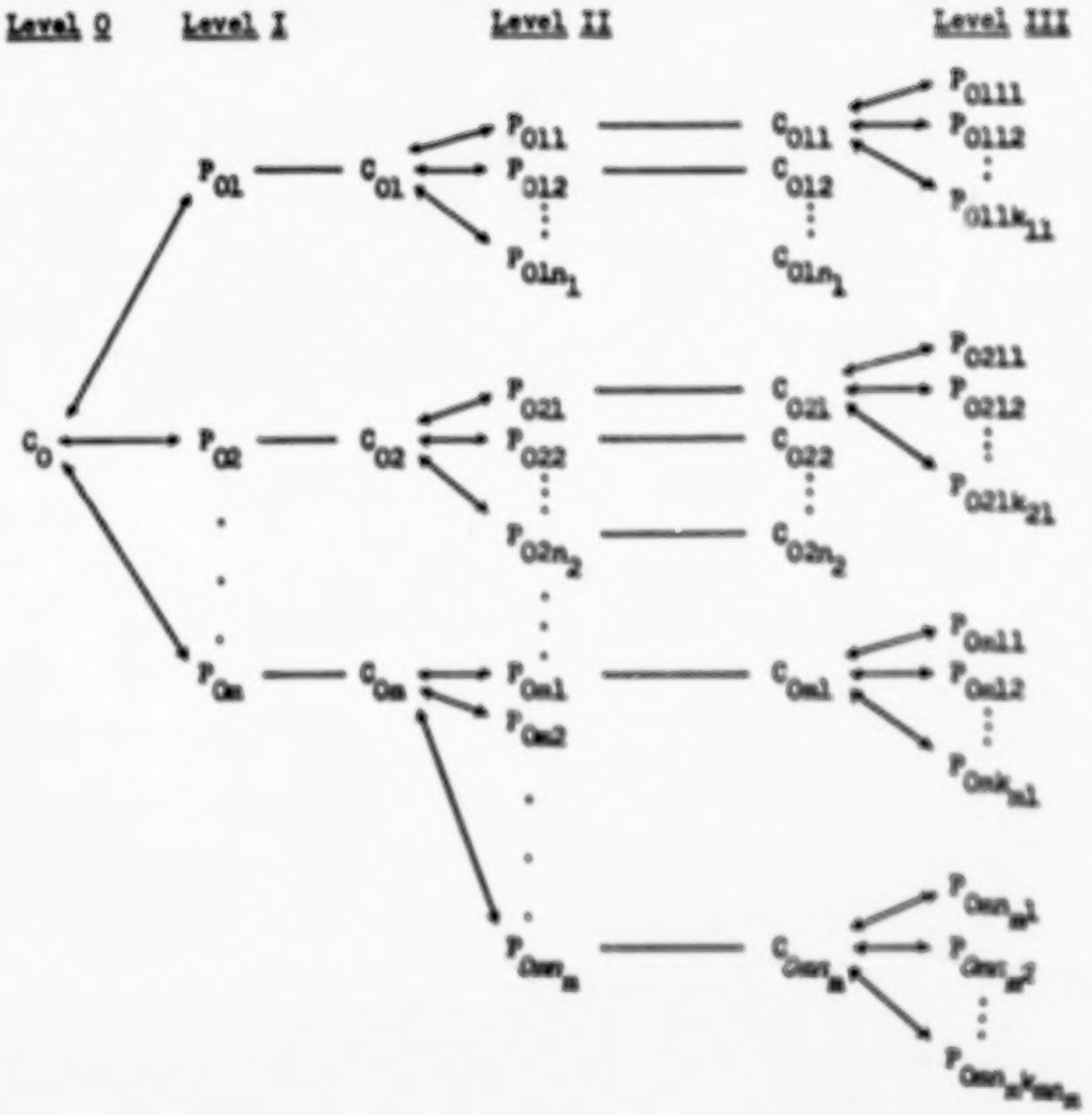
Level 0
Level I
Level II
Level III
C_0
P_{01}
C_{01}
P_{011}
P_{012}
P_{01n_1}
C_{011}
C_{012}
C_{01n_1}
P_{0111}
P_{0112}
$P_{011k_{11}}$
P_{02}
C_{02}
P_{021}
P_{022}
P_{02n_2}
C_{021}
C_{022}
C_{02n_2}
P_{0211}
P_{0212}
$P_{021k_{21}}$
P_{0m}
C_{0m}
P_{0m1}
P_{0m2}
P_{0mn_m}
C_{0m1}
C_{0mn_m}
P_{0m11}
P_{0m12}
$P_{0mk_{m1}}$
P_{0mn_m1}
P_{0mn_m2}
$P_{0mn_mk_{mn_m}}$

Figure 4a. Schematic Diagram with generalized notation of a substrata analysis through three levels.

Major criterion C_0 is undergirded by substrata factors P_{01}, P_{02},... P_{0m}. Each of these rest on a wider base at Level II. Likewise, at Level III the base is even broader. P_{0m} --- C_{0m} terminology is used to indicate an identity, except that what was considered a predictor is in turn considered a subcriterion.

From: Holmes, J. A., & Singer, H. The substrata-factor theory: substrata factor differences underlying reading ability in known-groups at the high school level. U. S. Office of Education Contracts 538 and 538A, 1961.

previously selected predictors. When this had occurred, Level I analysis was completed. The variance not accounted for in the major criterion at this point was then attributable to factors which had not been measured by the available pool of predictors in the correlation matrix.

The analysis then proceeded to the second substrata level. Each of the first level predictors that could be psychoeducationally analyzed further[1] became a subcriterion whose variance might be accounted for by the predictors in the correlation matrix that were not selected at the first level of analysis. Thus, the first level predictor, P_{01}, served as subcriterion C_{01} whose variance might be partialled out to some of the remaining predictors in the correlation matrix. These selected predictors for C_{01} are P_{011} through P_{01n_1}. This selection of predictors for C_{01} continued until stopped by the F-test. The analysis next proceeded to C_{02} and the process was repeated, again with a matrix in which the first level predictors as well as the major criterion had been eliminated. The analysis thus continued at the second level to the mth subcriterion, C_{0m}.

After the second level of analysis had been completed, the third began. Predictor P_{011} now became subcriterion C_{011} and its predictors were selected from among the pool of predictors remaining in the matrix after the major criterion and the first and second level predictors had been eliminated. Again, the analysis continued until stopped by an F-test. The selection of predictors for each criterion thus continued through the third substrata level.

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[1] Only those predictors become subcriteria which can be justifiably analyzed further because (a) variables remain in the matrix that according to hypothesis may account for variance in one or more subcriterion or (b) evidence from other studies indicate that the variance in the remaining subcriteria can be broken down into further subsystems that are represented by variables in the remaining pool of predictors. Hence, theory, hypothesis, or research evidence may provide the basis for judgment as to which predictors to analyze further and when to stop the substrata analysis.

The McNemar (1955) F-test, used as a stopping rule for the selection of predictors for a given criterion or subcriterion, is expressed by the following formula:

$$F = \frac{R_1^2 - R_2^2 \; / \; (m_1 - m_2)}{(1 - R_1^2) \; / \; (N - m_1 - 1)}$$

where: R_1 is the multiple correlation based on the selected m_1 variables,[1]

R_2 is the multiple correlation based on m_2 variables, selected from among the m_1 variables,

N is the sample size,

m_1 is the number of predictors previously selected, and

F is the resulting ratio which is determined to be or not to be significant by entering a table in which n_1 degrees of freedom $= m_1 - m_2$ and n_2 degrees of freedom $= N - m_1 - 1$.

Consequently, by use of the F-test, it is possible to determine whether or not another variable added to the submatrix already selected from the pool of predictors would make a statistically significant contribution to the criterion under consideration. Hence the null hypothesis ($R_1 - R_2 = 0$) was tested at the one per cent level of confidence for each regression equation.

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[1] In this study, m was taken as the number of variables for computing R from the selection of just one more variable and inverting the matrix. Therefore, in each F-test, $m_1 - m_2 = 1$. This modification was used as the most conservative estimate for a random selection.

In the statistical model that results from simple structure substrata analysis, a predictor appears at only one level because once it has been selected at a particular level it is eliminated from the pool of predictors for the next level. This statistical model does not mean that in the dynamics of reading a predictor that is more closely associated with the major criterion could not enter into the neurological subsystem of another subcriterion at a lower level in an individual's general working system. On the contrary, it is very possible that it may do so, particularly as an individual's general working system for attaining speed and power of reading becomes more integrated. Thus, for example, P_{02} could be a substrata-factor or predictor for C_{01} or to state it more precisely, P_{02} could be a component in the neurological subsystem that is mobilized for solving a task in reading that primarily lies in the domain represented by the subcriterion, C_{01}. Such relationships could have been shown to some extent by another type of substrata analysis, "principal structure substrata analysis," which does not eliminate a predictor once it has been chosen.[1] The assumption, however, in simple structure is that the elimination of a predictor once it has been chosen permits other predictors to be selected that are more remotely related to the major criterion. These more remotely related predictors may represent subsystems that could be mobilized by the subcriterion which is more closely associated with the major criterion. Consequently, instead of masking these remote predictors, simple structure substrata analysis reveals the substrata levels at which these remotely related subsystems might be organized.

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[1] Principal structure substrata analysis has been used in earlier substrata-factor studies (Holmes, 1948, 1954; Singer, 1960, 1962). Both methods of analysis yield identical results for the first substrata level.

A discussion of the dynamics involved in the hierarchical organization of a working system for attaining speed or power of reading may clarify the complex structure that is possible. Theoretically, Level I substrata-factors are usually mobilized first in an active working system, but if a problem should arise which could not be solved by the working system that has already been mobilized, then another working system would be mobilized that would consist of those substrata-factors or neurological subsystems that are more remotely related to the major criterion, but which could be necessary for solving this particular problem. If this subsystem also were not successful in solving the problem then another working system would be mobilized by the individual until the problem was solved or the individual gave up and tried to go on in his reading without solving the problem. For instance, as implied in the flow chart shown in Figure 2, Chapter II: if an individual in trying to attain Power of Reading could not succeed with a working system that included a subsystem represented by Vocabulary in Isolation, which involves the recognition of a whole word at sight and knowledge of the meaning of the word, then the individual might mobilize a subsystem at a more remotely associated level in which he could utilize his knowledge of Suffixes and Word Recognition in Context plus his reasoning abilities. This second working system might then enable the individual to analyze the word and infer its meaning from context. If the individual still could not solve the problem at this level of organization, he might mobilize another working system that could include Spelling Recall, a substrata-factor that precipitated in the general working system at both the second and third substrata levels (Singer, 1962). This hierarchical process of organization may, of course, proceed so rapidly that the individual himself may be hardly aware of the dynamics. However, in the initial stages of instruction, when pupils read aloud, even though they had been permitted to read silently, the teacher can infer that this hierarchical reorganization process is in progress. By listening to a pupil's various attempts to recognize a word, or to obtain the meaning of a word, or to comprehend the idea of a sentence, the teacher can conclude that each attempt represents a reorganization in the individual's working system for solving a problem in reading.

Each model or flow chart constructed to represent the results of simple structure substrata analysis, of course, does not reveal the dynamic organizations that are possible.[1] Only the structure of subsystems that may exist along the continuum of nearness to or remoteness from the major criterion in the substrata level of organization is indicated in each model.

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[1] For example, the dynamics could also be explained in reverse order: subsystems can be sequentially mobilized into a hierarchical relationship that go from substrata levels which are remote to those which are more closely associated with speed or power of reading.

EXPLANATION OF STATISTICAL PROCEDURE AND TERMS USED IN SUBSTRATA ANALYSIS

The results of the Wherry-Doolittle-Holmes Simple Structure Substrata Analysis of Speed and Power of Reading for grades 3 through 6 appear in Tables E through L in the Appendix. The tables show the order of selection of predictors, the zero-order correlation of each predictor with the major criterion (r_0), the cumulative contributions to variance in the criterion or subcriterion over and above that accounted for by the previous predictors (V^2 / Z), and the cumulative multiple prediction, corrected for shrinkage, ($\bar{R}$), of the particular major criterion or subcriterion. In the Wherry Shrinkage formula,

$$\bar{R} = \sqrt{1 - K^2 (N - 1 / N - m - 1}$$

where: $\bar{R}$ = the "shrunken R" or the adjusted multiple correlation

$K^2 = 1 - R^2$, the biased estimate of the multiple correlation substracted from 1, or the variance of the biased coefficient of alienation.

N = sample size

m = the number of predictors selected

The correlation submatrix of the selected predictors and the criterion or subcriterion variable is then inverted and the elements of the matrix are substituted in the following general formula to obtain the beta weights and the multiple correlation (R):

$$\beta_{ij} = \frac{-r^{ij}}{r^{jj}}$$

where: β_{ij} is the beta weight for the i^{th} variable for the j^{th} criterion,

r^{ij} is the inverse element of the i^{th} variable for the j^{th} criterion,

r^{jj} is the inverse element of the j^{th} variable for the j^{th} criterion.

The beta weights for each predictor multiplied by its zero-order correlation with the criterion or subcriterion that is being predicted, prorated for shrinkage ($\overline{R}^2 / R^2$), constitute the components of the regression equation for predicting each criterion or subcriterion. In the general regression formula:

$$\overline{R}^2 = \overline{\beta_{01}r_{01}} + \overline{\beta_{02}r_{02}} + \overline{\beta_{03}r_{03}} + \overline{\beta_{0n}r_{0n}}$$

where:

$\overline{R}^2$ = the predicted variance, adjusted for shrinkage,

$\overline{\beta}$ = a beta weight or partial regression coefficient, computed from the inverse of the selected matrix, corrected for shrinkage; the generalized form of the beta coefficient is $\beta_{01.23\ldots n}$,

$\overline{r}$ = a zero-order correlation of the predictor with the criterion measure, Speed or Power of Reading, corrected for shrinkage.

The last computational step is to multiply each component of the regression equation by 100 to obtain the per cent contribution to variance for each predictor. Tables E through L in the Appendix also show the beta weights (β) for each regression equation and the contributions to variance, corrected for shrinkage, made by each component in the regression equation ($\overline{\beta r_0}$) to the variance in the predicted criterion or subcriterion.

The per cent contribution for each selected predictor is listed in Tables E through L in the Appendix and is also shown adjacent to each predictor in the flow charts in subsequent chapters. These per cent contributions to variance contain both the separate coefficient of determination and one-half of the coefficient of determination that is shared with other predictors selected to account for variance in a particular criterion. The joint or shared variances, of course, can be calculated separately (Chase, 1958, 1960), but this type of computation only answers one kind of question. The answer to another type of question was sought in this study: how much of a criterion's variance can be attributed to the _total_ _influence_ of each of the selected predictors? To answer this question, it was only necessary to multiply each component in the regression equation by 100 to obtain per cent contributions (separate plus joint) made by each predictor for a particular criterion. The argument for this procedure for obtaining per cent contributions to variance in order to answer the type of question posed by this study was succinctly stated by Holmes and Singer (1961, p. 87):

> ...each of the preferential predictors selected because it made an independent contribution to the variance of the criterion also entered into a joint relationship with other selected predictors to the end that each shared in what can be thought of as an additional contribution to the criterion's variance. This shared variance can be divided between the partners by prorating the total amount in terms of the coefficient of separate determination attributable to each, or by simply dividing the shared amount equally and assigning each half to the appropriate partners. The technique employed in the present study of multiplying the betas by the zero-order r's is tantamount to the latter alternative; that is, using the coefficient of separate determination plus one-half of the coefficient of shared determination in Wright's (1921) sense in order to account for the total influence (independent and shared) that a preferential predictor might exert on the criterion. _This is justified according to Ezekiel_ (1953), _since these two methods have a mathematical equality_.

As implied by this discussion on computation of contributions to variance, the set of predictors or substrata-factors for a particular criterion or subcriterion do have some degree of interaction. Consequently, the flow charts or models in the following chapters should be viewed as having interconnecting lines of association among predictors to represent shared contributions to variance. Dynamically, these lines of association would imply the possibility of some degree of cortical interfacilitation among the neurological subsystems mobilized into a working system for attaining speed or power of reading, or for solving a particular problem encountered in the course of reading. For example, an individual might know a word at sight (Vocabulary in Isolation), but also derive some enhancement for the meaning of the word from association or communication with the auditory domain as tapped by Matching Word Sounds (Singer, 1962). Theoretically, then, the auditory domain would be associating with the visual domain, perhaps through inner speech or neurological communication, whatever meaning for the word that is stored within the auditory memory system (Holmes, 1957).

THREE DIMENSIONAL SCHEMATIC OF THE EXPERIMENTAL DESIGN

Figure 4b shows a three dimensional schematic of simple structure substrata analysis of Speed and Power of Reading for grades 3 through 6. In this figure, each block represents a grade level. The three substrata levels for each major criterion, as shown on the front of the figure, should be visualized as also occurring in schematic form in each block. Substrata analysis for Speed of Reading appears on the left side and for Power of Reading on the right side of each block.

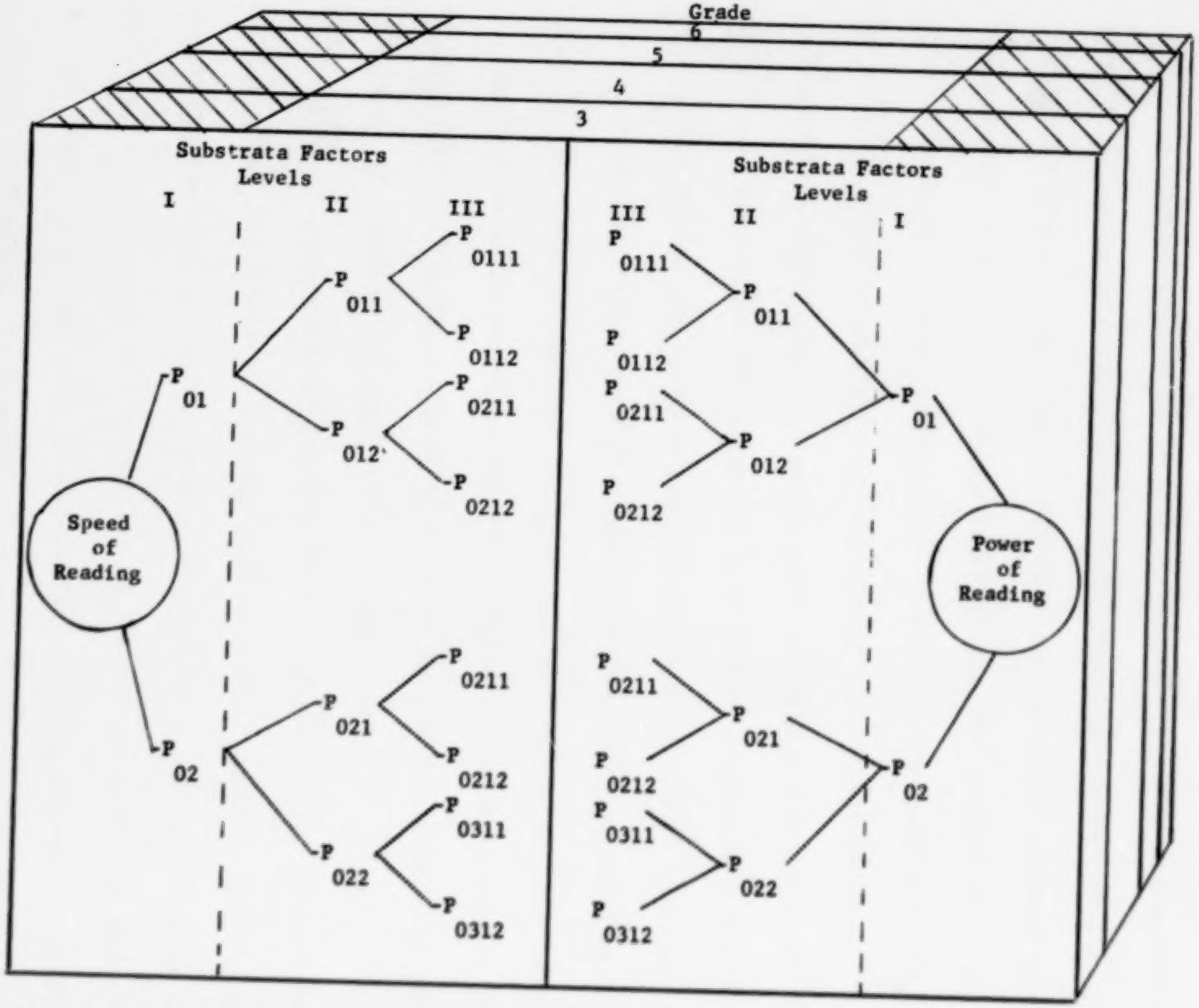
Grade
6
5
4
3
Substrata Factors Levels
I
II
III
Speed of Reading
P 01
P 02
P 011
P 012
P 021
P 022
P 0111
P 0112
P 0211
P 0212
P 0211
P 0212
P 0311
P 0312
Substrata Factors Levels
III
II
I
Power of Reading
P 0111
P 0112
P 0211
P 0212
P 011
P 012
P 01
P 0211
P 0212
P 0311
P 0312
P 021
P 022
P 02

Figure 4b. Three dimensional schematic design of simple structure substrata analysis for Speed and Power of Reading for grades 3 through 6. The sections on each end of the figure represent developmental models of Level I Substrata Factors for Speed and Power of Reading.

An overview of the experimental design of this study can be gleaned by looking at Figure 4b from three perspectives:

(1) Each block can be looked at separately for a representation of simple structure substrata analysis for Speed and Power of Reading at a particular grade level. The flow chart or the model constructed from the results of substrata analysis represents the organization of the general working system that could be mobilized for attaining Speed and Power of Reading by the average individual at each grade level. In subsequent chapters, these results will be depicted in separate flow charts for each major criterion at each grade level. Each chart will, therefore, depict one-half of each block of Figure 4b. However, comparisons of the flow charts for Speed and for Power of Reading at each grade level could reveal the factors that are common to both components, as has been done in previous substrata-factor studies to reveal the interrelationships in the general working system for attaining Speed and Power of Reading (Holmes, 1954; Singer, 1962).

(2) A developmental model for Speed of Reading and another developmental model for Power of Reading will be constructed by depicting Level I substrata-factors across the grade levels. This construction is tantamount to a cross-sectional side view of the slice formed by the small dotted lines on either side of Figure 4b. Since performance in Speed or Power of Reading, in general, increases from grade to grade, as was shown in Table 3, comparison of these first level predictors or substrata-factors across the grades could reveal whether there are any systematic changes, qualitative or quantitative, in the organization of the average individual's general working system concomitant with improvement in Speed

and Power of Reading. If so, then the major hypothesis of this study would be confirmed.

(3) Developmental reorganization in the hierarchy of the general working system as the average individual improves in Speed and Power of Reading will be ascertained by noting whether or not there are any systematic changes in the hierarchical position of any predictor or substrata-factor from grade to grade. Such an analysis is tantamount to a side view of each half of the figure. This reorganization might also indicate that those variables which could be categorized in the visual vs. the auditory domains do change their relative places in the hierarchy; if the visual factors become more closely positioned while the auditory factors become more remotely positioned to either major component of reading, as the average individual improves in Speed and Power of Reading, then the minor hypothesis of this study would also be confirmed.

The flow charts for Speed of Reading will be presented in Chapter V and for Power of Reading in Chapter VI. The developmental models for Speed and Power of Reading will be shown in Chapter VII. The results of the analysis to determine whether there are systematic changes in subsystems or a hierarchical reorganization in the general working system concomitant with improvement in Speed and Power of Reading will also be depicted and interpreted in Chapter VII.

CHAPTER V

SUBSTRATA ANALYSIS OF SPEED OF READING IN GRADES 3 THROUGH 6

The question that this chapter seeks to answer is the following: as determined by a substrata analysis of the variables assessed in this study, what is the structural organization of substrata-factors underlying Speed of Reading at each grade level? To answer this question, the results of substrata analyses of Speed of Reading for grades 3 through 6 are presented in flow charts, Figures 5, 6, 7, and 8, respectively.[1] Each flow chart depicts the structural organization of substrata-factors underlying Speed of Reading at a particular grade level. Adjacent to each predictor or substrata-factor is its per cent contribution to variance in (a) the major criterion, Speed of Reading, for Level I predictors and (b) subcriteria for Level II and Level III predictors. The per cent variance in the major criterion at each grade level that has not been accounted for by the components in its regression equation must be attributable to variables that have not been included in the test battery. The flow chart for each grade level will be presented and discussed separately. Although some changes in structural organization of the general working system from one grade level to another may be noted in this discussion, primary emphasis upon these changes will be reserved for Chapter VII.

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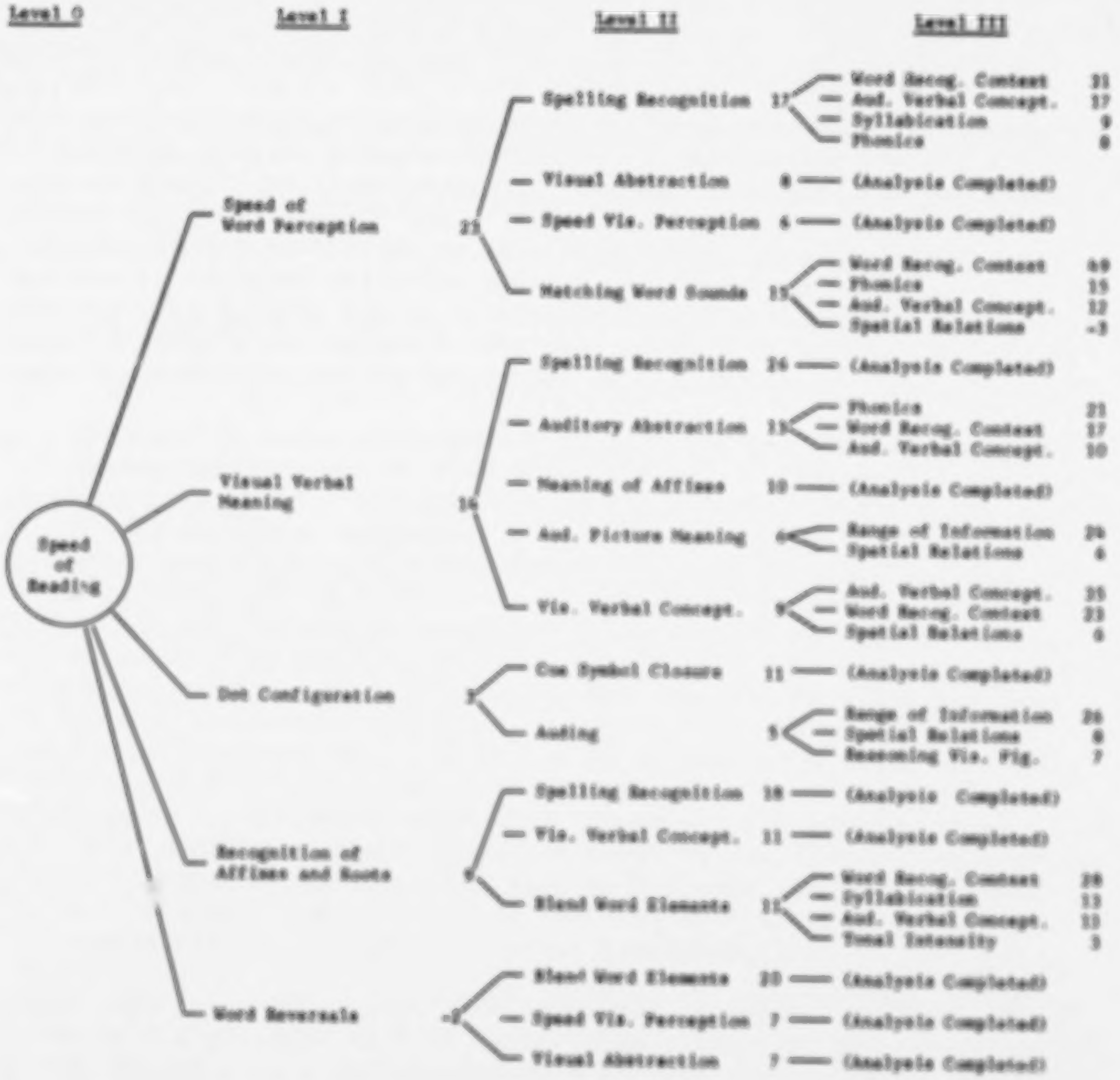
[1] The zero-order correlation matrices and the statistical results of substrata analyses of Speed of Reading for grades 3 through 6 are located in the Appendix, Tables A through D and E through H, respectively.

RESULTS OF SUBSTRATA ANALYSIS FOR SPEED OF READING

Grade 3. The flow chart at the third grade level, Figure 5, is to be read in the following way: At Level I, five factors precipitated from the analysis to account for 47 per cent of the variance in Speed of Reading: Speed of Word Perception, 23%; Visual Verbal Meaning, 14%; Dot Configuration, 3%; Recognition of Affixes and Roots, 9%; and Word Reversals, -2%. Speed of Word Perception, the ability to recognize words and phrases quickly, is a compound measure of speed and span of word recognition. Visual Verbal Meaning measures the ability to recognize a word and match it with a synonym. Recognition of Affixes and Roots is a test of the ability to perceive commonly recurring and meaningful components of words. Dot Configuration involves the ability to perceive quickly and accurately a letter or number embedded in a cloud of dots. Word Reversals, designed to assess perceptual control over word perception, requires rapid recognition of a multiple choice word spelled backwards, such as "time" and "emit." Therefore, at this grade level, individual differences in Speed of Reading is dependent upon a linear combination of at least the following factors: (a) the ability to rapidly perceive and process a relatively broad unit of word perception, or (b) to construct such perceptions accurately from reduced cues, (c) perceive meaningful combinations of word parts, such as affixes and roots, perhaps as an aid in word recognition, (d) select and respond with appropriate meanings to the perceptions of words and phrases being processed, and (e) enhance the accuracy of all these perceptions, but at a slight cost in Speed of Reading, as indicated by the


Level 0
Level I
Level II
Level III
Speed of Reading
Speed of Word Perception 23
Spelling Recognition 17
Word Recog. Context 31
Aud. Verbal Concept. 17
Syllabication 9
Phonics 8
Visual Abstraction 8
(Analysis Completed)
Speed Vis. Perception 6
(Analysis Completed)
Matching Word Sounds 15
Word Recog. Context 49
Phonics 15
Aud. Verbal Concept. 12
Spatial Relations -3
Visual Verbal Meaning 16
Spelling Recognition 26
(Analysis Completed)
Auditory Abstraction 13
Phonics 21
Word Recog. Context 17
Aud. Verbal Concept. 10
Meaning of Affixes 10
(Analysis Completed)
Aud. Picture Meaning 6
Range of Information 26
Spatial Relations 6
Vis. Verbal Concept. 9
Aud. Verbal Concept. 35
Word Recog. Context 23
Spatial Relations 6
Dot Configuration 3
Cue Symbol Closure 11
(Analysis Completed)
Auding 5
Range of Information 26
Spatial Relations 8
Reasoning Vis. Fig. 7
Recognition of Affixes and Roots 9
Spelling Recognition 18
(Analysis Completed)
Vis. Verbal Concept. 11
(Analysis Completed)
Blend Word Elements 11
Word Recog. Context 28
Syllabication 13
Aud. Verbal Concept. 13
Tonal Intensity 3
Word Reversals -2
Blend Word Elements 20
(Analysis Completed)
Speed Vis. Perception 7
(Analysis Completed)
Visual Abstraction 7
(Analysis Completed)

Note: All values
expressed in per cent

Figure 5. Flow Chart to Show Results of Substrata Analysis of Speed of Reading, Third Grade Level

negative contribution to variance made by Word Reversals.[1]

At the next level of analysis, the question was raised: from the remaining variables in the matrix, what factors account for variance in

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[1] The small, negative contributions to variance made by Word Reversals at grade 3, Spatial Relations at grade 4, and Auditory Verbal Abstraction at grade 5 are interpreted as meaning that these factors either reduce the prediction of Speed of Reading or act as statistical suppressor-like purifiers; as such, they augment the combined contributions to variance which the other predictors make to Speed of Reading. As pointed out by Holmes and Singer (1961): Snedecor (1946); Ezekiel (1953); and Holmes (1954) have given similar explanations of negative contributions to variance. Ezekiel wrote:

> Off-hand it seems difficult to explain how the 'determination' of any variable can be less than nothing.... The explanation is simple, however. Although the total variation in the estimates of the dependent variables is obtained by adding the contributions of several independent variables, it does not follow that all the variables will be influencing the estimate in the same direction at the same time--all tending to give low values when the actual value is low, or all tending to give high values when the actual value is high. It sometimes happens that one variable may tend to work counter to the other variables, usually preventing the final estimate from going so low as it otherwise would when the general effect is downward and tending to keep it from going so high as it otherwise would when the others are forcing it up. It is under such conditions that negative coefficients of separate determination are obtained; they do not mean that the variable has no significance, but that its influence is usually exerted counter to the influence of other variables.

Lubin (1957, p. 292) stated that given two predictor variables V and X, where the validity of V is higher than that of X, then subtracting X from V will give a difference score D, such that $r_{dc} > r_{vc}$ when the following equation obtains:

$$r_{xv} > 1/2 \left[\sigma_x / \sigma_v + 2r_{xc} / r_{vc} - \left(r^2_{xc} / r^2_{vc} \right) \sigma_x / \sigma_v \right]$$

Under these conditions. . . "X acts as if it were a suppressor."

each of the Level I predictors? Methodologically, the process consists of taking each of the Level I predictors now as a subcriterion and finding the minimum number of factors from the remaining pool of variables that tend to account for the maximum variance in each subcriterion. The results at the second level of analysis revealed the following predictors and their per cent contributions to the variance in each of the first level substrata-factors:

(a) Speed of Word Perception: Spelling Recognition, 17%; Visual Verbal Abstraction, 8%; Speed of Visual Perception, 6%; and Matching Word Sounds, 15%.

By taking these Level II predictors as subcriteria and looking at the Level III substrata-factors in Figure 5 which account for some of the variance in each of them, an empirically based interpretation can be given for the Level II predictors. For example, 65% of the variance in Spelling Recognition is attributable at the third level of analysis to Word Recognition in Context, 31%; Auditory Verbal Conceptualization, 17%; Syllabication, 9%; Phonics, 8%. Thus word recognition processes and conceptual ability can be mobilized to attain success in Spelling Recognition. Visual (Verbal) Abstraction could not be analyzed further at this level, but it involves the ability to rapidly perceive, abstract, and form a general response to common visual verbal elements.[1]

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[1] At the second or third substrata level, the analysis may be "completed" because (a) no variable(s) remain in the pool of predictors that could reasonably account for variance in the particular subcriterion or (b) an analysis of the particular subcriterion has already been made at that particular level, as shown by inspecting and finding the particular subcriterion again at a higher position in that particular level of substrata analysis.

This general response subsequently acts as a mediator to the same common elements.

Speed of Visual Perception is simply the ability to perceive an identity relationship for non-meaningful stimuli or to match up a visual stimulus with its corresponding image. Matching Word Sounds at this level calls upon a set of skills that qualitatively, but not quantitatively, are similar to those that could be mobilized for Spelling Recognition. However, Matching Word Sounds also consists of the ability to sound out a word; the residual or unexplained variance in Matching Word Sounds may reside in this auditory component. If so, then this auditory component enters into the variance in Speed of Word Perception. Perhaps at the third grade level, sounding out the word, overtly or through inner speech, may accelerate its recognition and facilitate its retention.

(b) Visual Verbal Meaning: Spelling Recognition, 26%; Auditory Abstraction, 13%; Meaning of Affixes, 10%; Auditory Picture Meaning, 6%; and Visual Verbal Conceptualization, 9%. Taking into account the Level III predictors shown in Figure 5, a working system for Visual Verbal Meaning could be mobilized that contained such factors as the ability to perceive and recognize words, listen to words and abstract common sounds, use knowledge of suffixes to obtain the meaning of words, associate visual images to heard words and information, and formulate ideas by abstracting them from context and grouping them into ideas perhaps by means of a superordinating strategy (Bruner and Olver, 1963).

(c) Dot Configuration: Cue Symbol Closure, 11%; Auding, 5%. Dot Configuration involves the ability to make fine visual discriminations, an ability that may be utilized for discriminating and forming the correct response to such words as "net" and "not." Often in rapid reading, these discriminations may be based upon the ability to complete a figure when given reduced cues (Cue Symbol Closure). Components of Auding, which includes information, mental manipulation of visual images, and reasoning about visual figures, may be mobilized to stimulate the visual perceptual processes.

(d) Recognition of Affixes and Roots: Spelling Recognition, 18%; Visual Verbal Conceptualization, 11%; and Blending Word Elements, 11%. Thus letters or word elements may be grouped into perceptual units that are meaningful by mobilizing a combination of auditory word recognition abilities and utilizing one's capability for perceiving, abstracting, and categorizing recurring visual verbal patterns.

(e) Word Reversals: Blending Word Elements, 20%; Speed of Visual Perception, 7%; and Visual (Verbal) Abstraction, 7%. Rapid visual perception, discrimination, and abstraction of words and the ability to control the resulting visual image well enough, even to the extent of reversing the image without perceptual confusion, give an individual speed, efficiency, and accuracy in word perception, but at a slight cost in overall rate of reading.[1]

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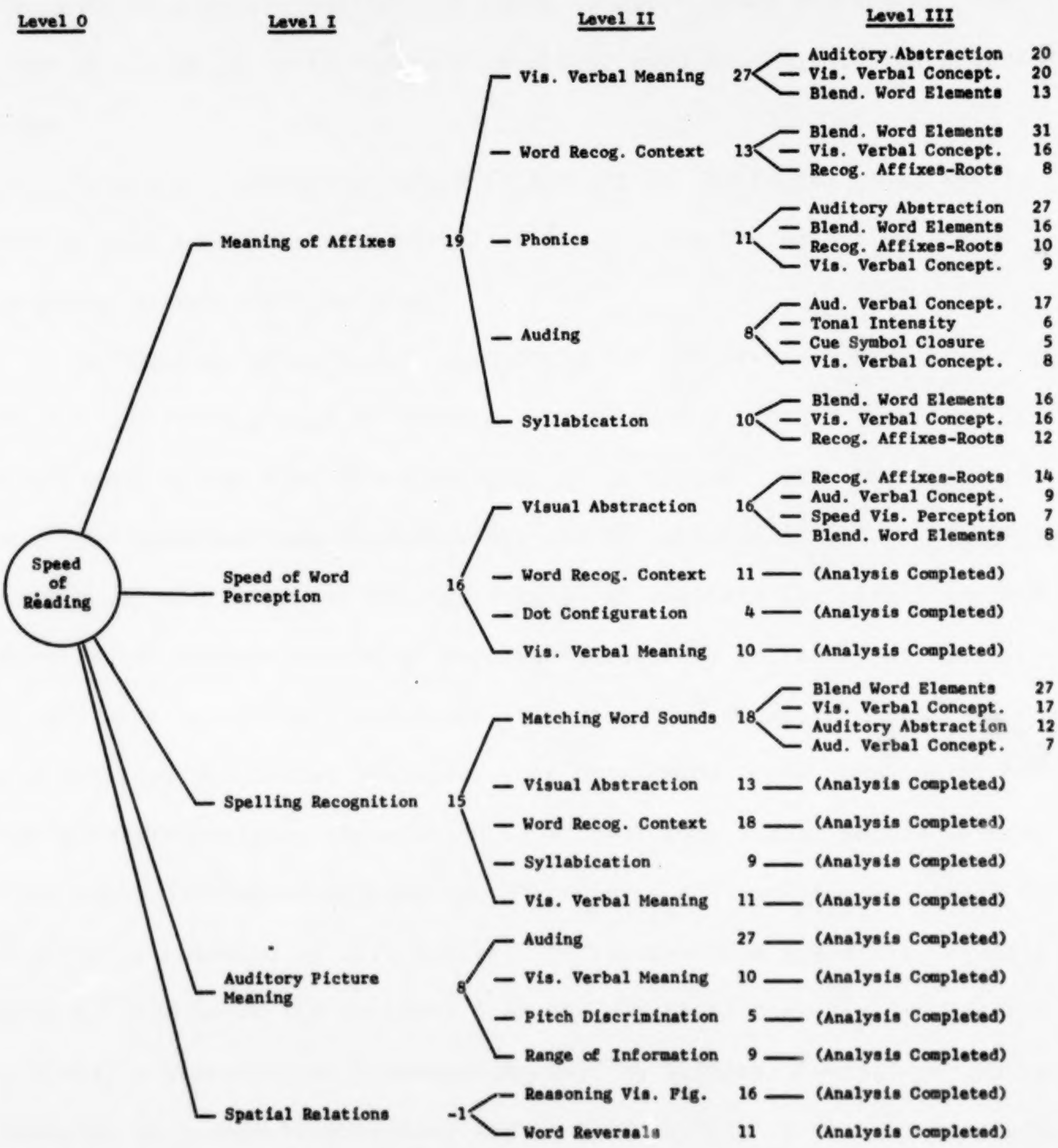
[1] Substrata analysis terminated at the third level because a diminishing point of return had been reached at this level. If per cent contributions are multiplied through each level, the amount of variance in the major criterion that could be accounted for by factors at the third level is indeed small. For example, in the third grade, Speed of Word Perception accounts for 23% of the variance in Speed of Reading. Then, 17% of the variance in Speed of Word Perception is attributable to Spelling Recognition. Finally, 31% of the variance in Spelling Recognition can be prorated to Word Recognition in Context. By multiplying these variances to get at the amount of the variance in the criterion that can be prorated to Word Recognition in Context through this set of subsystems, the resulting equation would be 31% x 17% x 23% = 1.2%. The logic of this proration was presented in a paper by Holmes (1964) and appears in the monograph by Holmes and Singer (1965).

Thus, at the third grade level there are five substrata sequences: speed of visual discrimination, speed and span of word perception, and verbal perceptual control together with perceptual grouping of meaningful letter patterns and association of word meaning. The emphasis at this level is primarily upon speed of visual verbal perception. Surprisingly, only 47% of the variance in Speed of Reading could be accounted for at the third grade level by the available pool of predictors.

Grade 4. The flow chart in Figure 6 depicts the results of substrata analysis of Speed of Reading at the fourth grade level. Five factors accounted for 57 per cent of the variance in Speed of Reading: Meaning of Affixes, 19%; Speed of Word Perception, 16%; Spelling Recognition, 15%; Auditory Picture Meaning, 8%; and Spatial Relations, -1%.

The processes utilized and the information stored in these factors can be inferred from a description of the variables that are dominant in each factor. The ability to select a particular phrase that contains the meaning of a prefix or suffix attached to a given word was measured by Meaning of Affixes. Speed of Word Perception has already been described. Spelling Recognition is a multiple-choice type of spelling test that may be categorized as a visual word recognition ability and perhaps assesses visual memory images for words. Auditory Picture Meaning consists of associating a heard word with a picture or the attainment at least of a concrete level of word meaning. Spatial Relations is a type of visual perceptual control which consists of the ability to recognize a figure rotated in two or three dimensional space. Thus, at the fourth grade, individual differences in Speed of Reading that could be accounted for by the variables in the test battery are attributable to a rapid span


Level 0
Level I
Level II
Level III
Speed of Reading
Meaning of Affixes
19
Vis. Verbal Meaning
27
Auditory Abstraction 20
Vis. Verbal Concept. 20
Blend. Word Elements 13
Word Recog. Context
13
Blend. Word Elements 31
Vis. Verbal Concept. 16
Recog. Affixes-Roots 8
Phonics
11
Auditory Abstraction 27
Blend. Word Elements 16
Recog. Affixes-Roots 10
Vis. Verbal Concept. 9
Auding
8
Aud. Verbal Concept. 17
Tonal Intensity 6
Cue Symbol Closure 5
Vis. Verbal Concept. 8
Syllabication
10
Blend. Word Elements 16
Vis. Verbal Concept. 16
Recog. Affixes-Roots 12
Speed of Word Perception
16
Visual Abstraction
16
Recog. Affixes-Roots 14
Aud. Verbal Concept. 9
Speed Vis. Perception 7
Blend. Word Elements 8
Word Recog. Context 11 (Analysis Completed)
Dot Configuration 4 (Analysis Completed)
Vis. Verbal Meaning 10 (Analysis Completed)
Spelling Recognition
15
Matching Word Sounds
18
Blend Word Elements 27
Vis. Verbal Concept. 17
Auditory Abstraction 12
Aud. Verbal Concept. 7
Visual Abstraction 13 (Analysis Completed)
Word Recog. Context 18 (Analysis Completed)
Syllabication 9 (Analysis Completed)
Vis. Verbal Meaning 11 (Analysis Completed)
Auditory Picture Meaning
8
Auding 27 (Analysis Completed)
Vis. Verbal Meaning 10 (Analysis Completed)
Pitch Discrimination 5 (Analysis Completed)
Range of Information 9 (Analysis Completed)
Spatial Relations
-1
Reasoning Vis. Fig. 16 (Analysis Completed)
Word Reversals 11 (Analysis Completed)

Note: All values
expressed in per cent

Figure 6. Flow Chart to Show Results of Substrata Analysis of Speed of Reading, Fourth Grade Level

of word perception, control over visual perceptual processes, visual word recognition ability, analysis of words to obtain word meaning and the association of at least concrete levels of word meanings to the printed page.

To explain substrata Levels II and III at the fourth grade level, let us take each substrata-factor at Level I and follow its substrata sequence across the flow chart:

(a) Meaning of Affixes: Accounting for 69% of the variance in this factor are three groups of factors: word meaning (Visual Verbal Meaning, 27%), word recognition (Word Recognition in Context, 13%; Phonics, 11%), auditory comprehension (Auding, 8%), and Syllabication, 10%. Underlying this group of factors at the third level of analysis are visual and auditory verbal conceptualization processes; auditory abstraction; auditory-visual word recognition processes (Blending Word Elements); and both visual and auditory perceptual processes. At this grade level, Meaning of Affixes has a slightly higher correlation ($r = .641$) than Visual Verbal Meaning ($r = .631$) with Speed of Reading. Therefore, the variance in Visual Verbal Meaning is subsumed by this factor. To reverse this substrata sequence and proceed from Level III to Level I in the substrata sequence for Meaning of Affixes, a hierarchical progression would be evident: verbal perception, abstraction, conceptualization, and finally ability to utilize knowledge of affixes together with other first level predictors to obtain Speed of Reading. Note also that Meaning of Affixes was a second level factor at grade 3 but has become a first level factor at grade 4. This shift in Meaning of Affixes from Level II to Level I with improvement in Speed of Reading is consistent with the hypothesis that a developmental change occurs in hierarchical organization of the general working system as individuals, in general, improve in Speed of Reading.

(b) *Speed of Word Perception* has a substrata sequence that is similar to its substrata sequence at the third grade level. However, it should be noted that at the fourth, but not at the third grade level, Visual Verbal Meaning accounted for some of the variance in Speed of Word Perception. This difference in processes underlying Speed of Word Perception suggests that word meaning accompanies more rapid speed and span of word perception at this grade level.

(c) *Spelling Recognition*: This visual word recognition ability, like Meaning of Affixes, precipitated as a second level factor at the third grade but is a first level factor at the fourth grade. Accounting for 69 per cent of its variance are word recognition factors (Matching Word Sounds, 18%; Syllabication, 9%; and Word Recognition in Context, 18%), a visual (verbal) abstraction factor, 13%; and a visual verbal meaning factor, 11%.

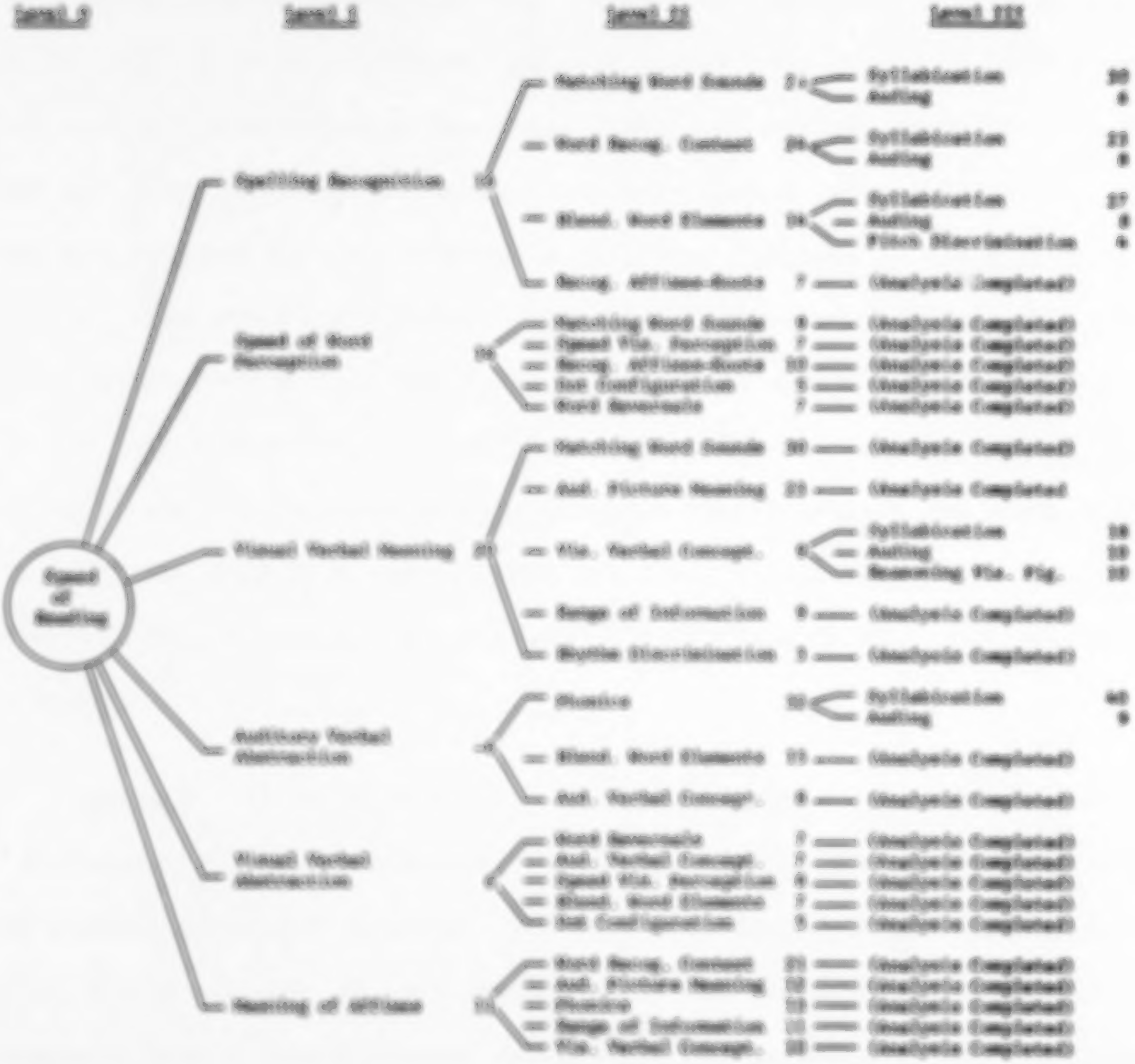
(d) *Auditory Picture Meaning*: Both auditory (Auding, 27%) and visual verbal comprehension (Visual Verbal Meaning, 10%), general information (Range of Information, 9%), and ability to detect differences in sound (Pitch Discrimination, 5%) account for 51% of the variance in this factor.

(e) *Spatial Relations*: The fact that Word Reversals accounts for some of the variance in Spatial Relations indicates that these factors are similar. More reasoning processes, however, are involved in Spatial Relations, as shown by one of its predictors, Reasoning with Visual Figures (16%), than was involved in Word Reversals at the third grade.

Thus, at the fourth grade level there are five substrata sequences: speed and span of word perception, visual perceptual control, visual word recognition ability, meaning of word parts, and concrete level of word meanings.

Grade 5. Figure 7 shows that six factors accounted for 61 per cent of the variance in Speed of Reading at the fifth grade: Spelling Recognition, 16%; Speed of Word Perception, 14%; Visual Verbal Meaning, 20%; Auditory Verbal Abstraction, -6%; Visual Verbal Abstraction, 6%; and Meaning of Affixes, 11%. Only two substrata sequences of the factors which had not precipitated as first level predictors at grades 3 and 4 will be discussed. Visual Verbal Abstraction, the ability to perceive the same stimulus word when embedded among varying letters, is analogous to the abstraction of a root word that has been perceived in several, somewhat different words; Auditory Verbal Abstraction is a similar ability for phonic elements, but in the fifth grade matrix has a suppressor-like effect, perhaps augmenting the contribution of the other factors by suppressing phonic elements with the result that the working system is then composed of more purely visual components.

At the second level of analysis, Visual Verbal Abstraction has 34 per cent of its variance distributed among the following factors: Word Reversals, 7%; Auditory Verbal Conceptualization, 7%; Speed of Visual Perception, 8%; Blending Word Elements, 7%; and Dot Configuration, 5%. Hence, the ability to perceive rapidly and accurately on the basis of minimum visual cues, retain and compare perceptual images, blend word elements, and organize auditory verbal stimuli into ideas constitute subsystems that can be mobilized into a working system for attaining visual verbal abstraction. In turn, visual verbal abstraction can be mobilized with some other factors into a response system for attaining Speed of Reading.


Level 0
Level I
Level II
Level III
Speed of Reading
Spelling Recognition
Speed of Word Perception
Visual Verbal Meaning
Auditory Verbal Abstraction
Visual Verbal Abstraction
Meaning of Affixes
Matching Word Sounds
Syllabication 30
Auding 6
Word Recog. Context 24
Syllabication 23
Auding 8
Blend. Word Elements 14
Syllabication 27
Auding 8
Pitch Discrimination 6
Recog. Affixes-Roots 7
(Analysis Completed)
Matching Word Sounds 8
Speed Vis. Perception 7
Recog. Affixes-Roots 10
Ink Configuration 5
Word Reversals 7
Matching Word Sounds 30
Aud. Picture Meaning 23
Vis. Verbal Concept. 6
Syllabication 18
Auding 18
Reasoning Vis. Fig. 13
Range of Information 9
Rhythm Discrimination 3
Phonics 10
Syllabication 40
Auding 9
Blend. Word Elements 13
Aud. Verbal Concept. 8
Word Reversals 7
Aud. Verbal Concept. 7
Speed Vis. Perception 6
Blend. Word Elements 7
Ink Configuration 5
Word Recog. Context 21
Aud. Picture Meaning 12
Phonics 13
Range of Information 11
Vis. Verbal Concept. 10

Note: All values
expressed in per cent

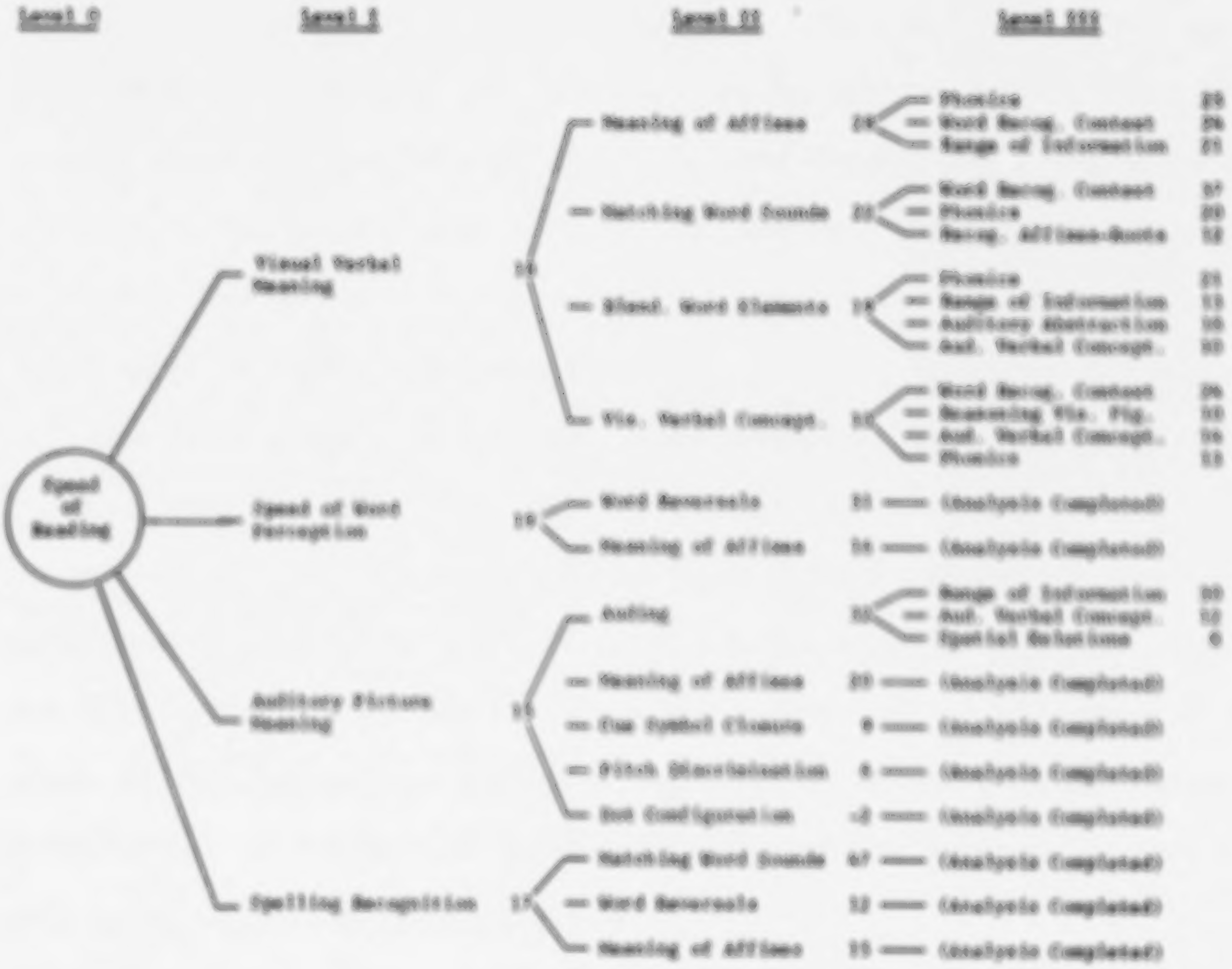
Figure 7. Flow Chart to Show Results of Substrata Analysis of Speed of Reading, Fifth Grade Level

Auditory Verbal Abstraction has 55 per cent of its variance distributed among these factors: Phonics, 32%; Blending Word Elements, 15%; and Auditory Verbal Conceptualization, 8%. Phonics was analyzed further at the third level into Syllabication, 40% and Auding, 9%. Blending Word Elements was also differentiated at the third level into Syllabication, 27%; Auding, 8%; and Pitch Discrimination, 4%. Auditory Verbal Conceptualization, however, was not analyzed further because no variables remained in the pool of predictors that could reasonably account for variance in this factor. Auditory Verbal Abstraction thus calls upon several auditory abilities: phonics or the same phoneme even though the grapheme may be different ("gem" and "jive"), ability to blend phoneme-grapheme relationships, and capability to organize ideas from stimuli that are presented through the auditory mode. However, this substrata-factor sequence acts, in general, as a suppressor subsystem.[1]

Grade 6. As shown in Figure 8, only four factors precipitated at the first substrata level to account for 69 per cent of the variance in Speed of Reading at the sixth grade. The fact that fewer factors accounted for more of the variance at this grade than at the preceding grade levels suggests that a more efficient integration has occurred in the substrata-factor organization for Speed of Reading. Another change is that 33% or

---

[1] Although this substrata-factor sequence acts as a negative component in the regression equation for predicting Speed of Reading, it tends to have a compensating role in the functioning of the general working system because it suppresses variance due to auditory subsystems. Consequently, subsystems that are more visual in their modality can then operate more efficiently for attaining rapid reading.


Level 0
Level I
Level II
Level III
Speed of Reading
Visual Verbal Meaning
16
Meaning of Affixes
28
Phonics
29
Word Recog. Context
26
Range of Information
21
Matching Word Sounds
22
Word Recog. Context
37
Phonics
20
Recog. Affixes-Roots
12
Blend. Word Elements
18
Phonics
21
Range of Information
13
Auditory Abstraction
10
Aud. Verbal Concept.
10
Vis. Verbal Concept.
32
Word Recog. Context
26
Reasoning Vis. Fig.
10
Aud. Verbal Concept.
16
Phonics
13
Speed of Word Perception
19
Word Reversals
21 —— (Analysis Completed)
Meaning of Affixes
16 —— (Analysis Completed)
Auditory Picture Meaning
15
Auding
32
Range of Information
10
Aud. Verbal Concept.
12
Spatial Relations
6
Meaning of Affixes
20 —— (Analysis Completed)
Cue Symbol Closure
8 —— (Analysis Completed)
Pitch Discrimination
6 —— (Analysis Completed)
Dot Configuration
-2 —— (Analysis Completed)
Spelling Recognition
17
Matching Word Sounds
67 —— (Analysis Completed)
Word Reversals
12 —— (Analysis Completed)
Meaning of Affixes
15 —— (Analysis Completed)

Note: All values
expressed in per cent

Figure 8. Flow Chart to Show Results of Substrata Analysis of Speed of Reading, Sixth Grade Level

almost half of the accounted for variance in Speed of Reading was distributed between two kinds of vocabulary factors: Visual Verbal Meaning, 18%, and Auditory Picture Meaning, 15%. Hence, both range and variety of vocabulary abilities are increasingly important in accounting for individual differences in development of Speed of Reading. The other two factors are Speed of Word Perception, 19%, and Spelling Recognition, 17%. These factors include speed and span of word perception and visual memory images for words. However, at the second level of analysis, auditory abilities may also be mobilized together with verbal perceptual control and word-part meaning to solve tasks in Spelling Recognition.

The sixth grader can mobilize, when necessary, all the factors at the previous grade levels, but at the sixth grade his range and variety of vocabulary abilities coupled with his speed and span of word perception and visual memory images for words give him his superiority. More than the less mature reader, the average sixth grader can not only take in more words at once and process them more rapidly, but he can also more adequately mobilize the necessary word meanings, whether at the concrete or abstract levels for attaining Speed of Reading.

SUMMARY

Substrata analyses of Speed of Reading revealed the following substrata sequences, identified by the first level predictors, in grades 3 through 6:

Grade	First Level Predictors	Per Cent Contribution to Variance in Speed of Reading
3	Dot Figure-Ground Configuration	3
	Speed and Span of Word Perception	23
	Word Reversals	- 2
	Recognition of Affixes and Roots	9
	Visual Verbal Meaning	14
	Total	47 %
4	Speed and Span of Word Perception	16
	Spatial Relations	- 1
	Spelling Recognition	15
	Meaning of Affixes	19
	Auditory Picture Meaning	8
	Total	57 %
5	Speed and Span of Word Perception	14
	Auditory Verbal Abstraction	- 6
	Visual Verbal Abstraction	6
	Spelling Recognition	16
	Meaning of Affixes	11
	Visual Verbal Meaning	20
	Total	61 %
6	Speed and Span of Word Perception	19
	Spelling Recognition	17
	Auditory Picture Meaning	15
	Visual Verbal Meaning	18
	Total	69 %

These results confirm the hypothesis that there are quantitative and qualitative changes in substrata-factor organization which accompany development in Speed of Reading in grades 3 through 6. Some of these changes in substrata-factor organization have been mentioned in the description and interpretation of the general working system for Speed of Reading at each grade level. However, stress upon these changes will be made in Chapter VII.

CHAPTER VI

SUBSTRATA ANALYSIS OF POWER OF READING IN GRADES 3 THROUGH 6

Parallel to the preceding chapter, but with a different major criterion to predict, the purpose of this chapter is to describe and interpret the structural organization of substrata-factors underlying Power of Reading at each grade level from 3 through 6. The structural organization for these grade levels, depicted in Figures 9, 10, 11, and 12, will be discussed separately for each grade level.[1] Although some changes from grade to grade in the general working system that could be mobilized for attaining Power of Reading may be noted, stress upon these changes will again be delayed till Chapter VII where developmental changes in substrata-factor organization accompanying Speed and Power of Reading in grades 3 through 6 will be diagrammatically presented and interpreted.

RESULTS OF SUBSTRATA ANALYSIS FOR POWER OF READING

Grade 3. Figure 9 reveals that at the third grade level, five factors accounted for 66 per cent of the variance in Power of Reading. Two word recognition factors contributed half of the predicted variance: Word Recognition in Context, the use of context to infer a missing word, accounted for 26%, and Syllabication, the application of syllabication rules to the division of words, accounted for another 7%. The remaining half of the predicted variance is distributed among the following three

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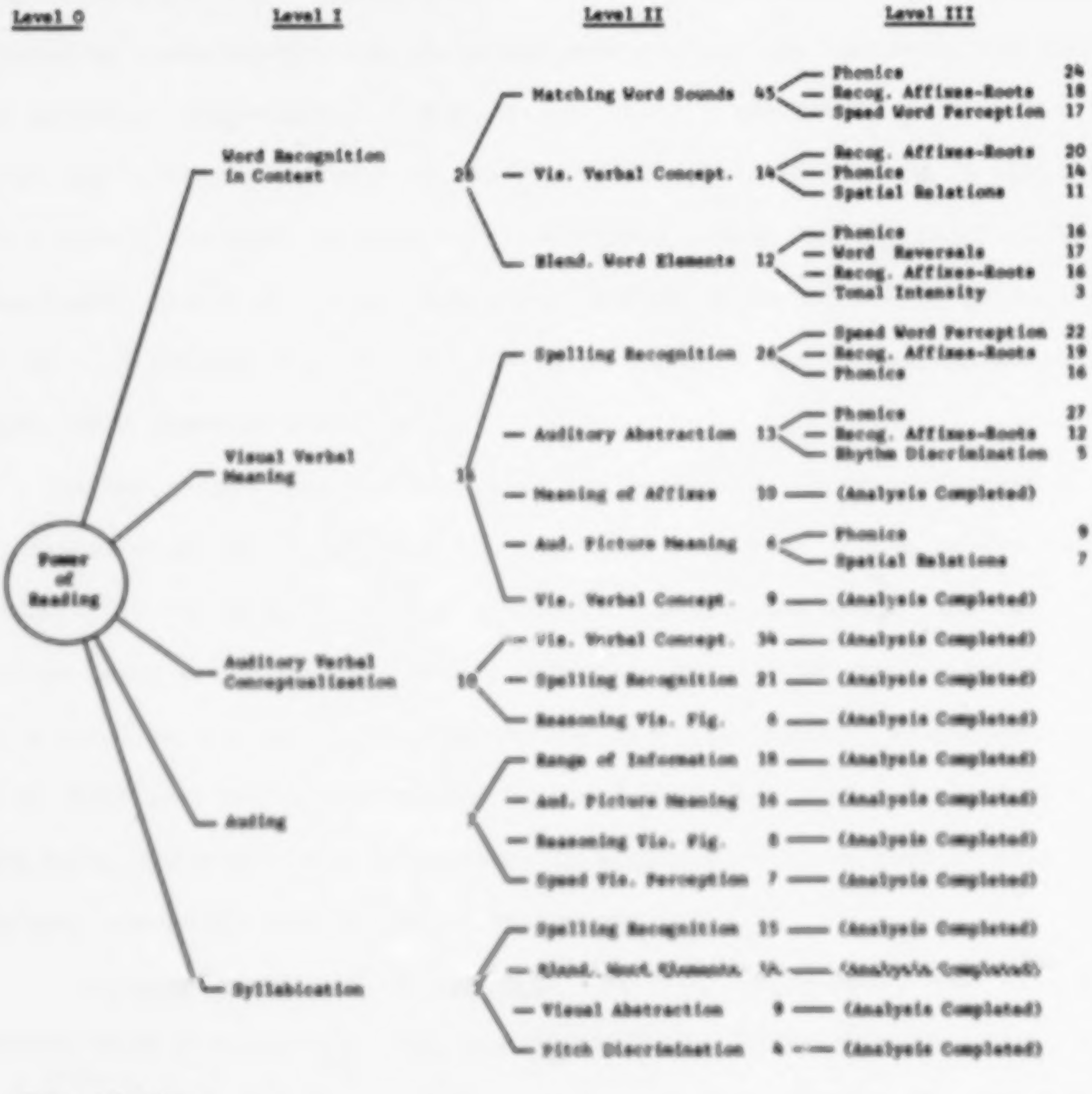
[1] Zero-order correlational matrices and the statistical results of substrata analyses of Power of Reading are reported in the Appendix in Tables A through D and I through L, respectively.


Level 0
Level I
Level II
Level III
Power of Reading
Word Recognition in Context
26
Matching Word Sounds 45
Phonics 24
Recog. Affixes-Roots 18
Speed Word Perception 17
Vis. Verbal Concept. 14
Recog. Affixes-Roots 20
Phonics 14
Spatial Relations 11
Blend. Word Elements 12
Phonics 16
Word Reversals 17
Recog. Affixes-Roots 16
Tonal Intensity 3
Visual Verbal Meaning
15
Spelling Recognition 26
Speed Word Perception 22
Recog. Affixes-Roots 19
Phonics 16
Auditory Abstraction 13
Phonics 27
Recog. Affixes-Roots 12
Rhythm Discrimination 5
Meaning of Affixes 10
(Analysis Completed)
Aud. Picture Meaning 6
Phonics 9
Spatial Relations 7
Vis. Verbal Concept. 9
(Analysis Completed)
Auditory Verbal Conceptualization
10
Vis. Verbal Concept. 34
(Analysis Completed)
Spelling Recognition 21
(Analysis Completed)
Reasoning Vis. Fig. 6
(Analysis Completed)
Auding
Range of Information 18
(Analysis Completed)
Aud. Picture Meaning 16
(Analysis Completed)
Reasoning Vis. Fig. 8
(Analysis Completed)
Speed Vis. Perception 7
(Analysis Completed)
Syllabication
Spelling Recognition 15
(Analysis Completed)
Blend. Word Elements 14
(Analysis Completed)
Visual Abstraction 9
(Analysis Completed)
Pitch Discrimination 4
(Analysis Completed)

Note: All values
expressed in per cent

Figure 9. Flow Chart to Show Results of Substrata Analysis of Power of Reading, Third Grade Level

factors: Visual Verbal Meaning, 16%; Auding, 7%; and Auditory Verbal Conceptualization, 10%. These factors consist of knowledge of word meaning, listening comprehension for words and stories, and the formation and use of concepts, respectively. Thus, at the third grade level, half of the predicted variance in Power of Reading is attributable to word recognition abilities or factors involved in transforming visual verbal stimuli into meaningful mental processes; the other half is accounted for by association of meaning through the auditory or visual modality and the organization of these word meanings into ideas.

At the second level of analysis, the following substrata-factors precipitated from the analysis of the remaining variables in the matrix to account for variance in each of the Level I predictors which have now become Level I subcriteria. The order of reporting the results below is to first list a Level I subcriterion and then its Level II predictors with their per cent contributions to variance in the particular subcriterion. The Level III predictors, also shown in Figure 9, will be used to help interpret the substrata-factors at the second level.

(a) *Word Recognition in Context*: Matching Word Sounds, 45%; Visual Verbal Conceptualization, 14%; and Blending Word Elements, 12%. Thus, 71% of the variance that can be mobilized into a working system for attaining Word Recognition in Context consists of the ability to sound out whole words; recognize, blend, and control images of word parts, and organize words into ideas.

(b) *Visual Verbal Meaning*: Spelling Recognition, 26%; Auditory Abstraction, 13%; Meaning of Affixes, 10%; Auditory Picture Meaning, 6%; and Visual Verbal Conceptualization, 9%. Thus, the ability to recognize the visual image of a word, abstract and organize ideas, utilize knowledge of meaningful parts of words, and call upon auditory-visual associations of word meanings are factors that can be mobilized to account for 64% of the variance in Visual Verbal Meaning.

(c) *Auditory Verbal Conceptualization*: Visual Verbal Conceptualization, 34%; Spelling Recognition, 21%; Reasoning with Visual Figures, 6%. Ability to recognize words and to reason with and without words in the visual modality can be mobilized for successful performance on a task that involves the ability to organize ideas from words that are presented through the auditory modality. However, the stimuli can be read simultaneously by the subject. Consequently, the individual could also utilize a visual input mode for this task.

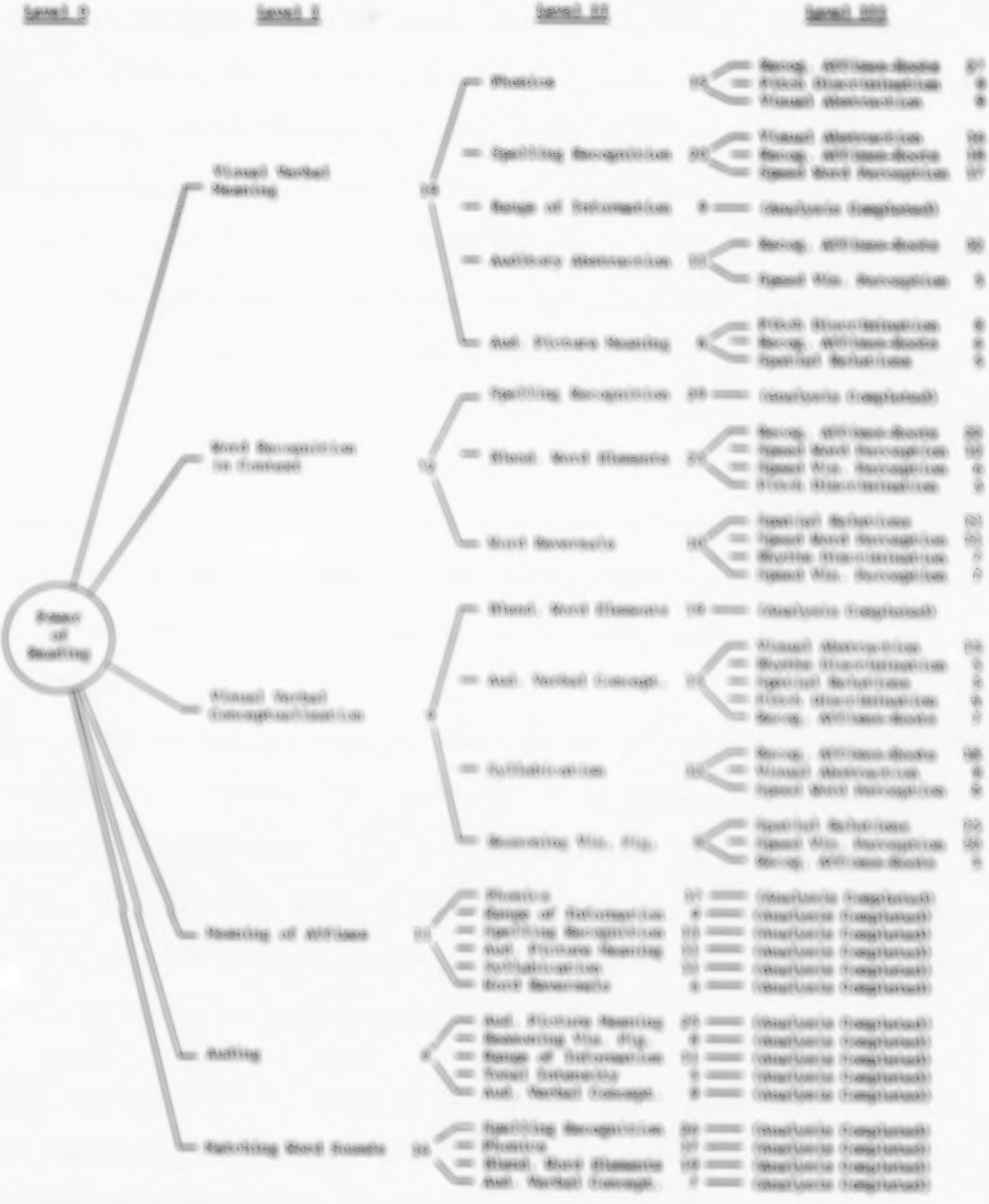
(d) *Auding*: Range of Information, 18%; Auditory Picture Meaning, 16%; Reasoning with Visual Figures, 8%; Speed of Visual Perception, 7%. Knowledge, auditory-visual association, reasoning, and speed of visual comparison are factors that can be mobilized for successful performance on a task that requires the individual to listen to a story and then identify a picture that answers a question on the story.

(e) *Syllabication*: For dividing words into syllables, an individual, in general, at the third grade level can mobilize a working system that includes Spelling Recognition, 15%; Blending Word Elements, 14%; Visual Abstraction, 9%; Pitch Discrimination, 4%. Thus, the complex ability to divide words into syllables calls upon a combination of visual and auditory factors. In the working system that can be mobilized to account for individual differences in syllabication are spelling recognition processes, blending words, abstracting common visual verbal elements, and discriminating pitches. Evidently, the ability to detect changes in pitch is utilized in syllabication. However, as is apparent from the substrata analysis of syllabication, pitch discrimination is only one subability in a complex working system that is mobilized for syllabifying words.

Grade 4. The following six factors precipitated from the matrix to account for 71% of the variance in Power of Reading at the fourth grade level, as shown in Figure 10: Visual Verbal Meaning, 19%; Word Recognition in Context, 12%; Visual Verbal Conceptualization, 9%; Meaning of Affixes, 11%; Auding, 6%; and Matching Word Sounds, 14%. The general working system that can be mobilized at the first substrata level in grade 4, therefore, consists of (a) recognition of words by sight, sound, or sentence sense, and (b) attainment of word meaning by utilizing an analytic process or by associating meaning from the auditory or visual modality, and finally (c) conceptualization or the organization and use of concepts.

Some hierarchical changes in substrata-factor organization have occurred between grades 3 and 4: the three "new" first level factors at the fourth grade level (Visual Verbal Conceptualization, Meaning of Affixes, and Matching Word Sounds) have moved up from second level substrata-factors. The following are the substrata sequences for the three new Level I factors:

(a) *Meaning of Affixes*: Phonics, 17%; Range of Information, 9%; Spelling Recognition, 13%; Auditory Picture Meaning, 11%; Syllabication, 11%; Word Reversals, 6%. The ability to use auditory and visual word recognition processes, identify affixes through syllabication, control visual images, and associate knowledge and word meanings from the auditory modality could,


Level O
Level I
Level II
Level III
Power of Reading
Visual Verbal Meaning
Word Recognition in Context
Visual Verbal Conceptualization
Meaning of Affixes
Rating
Matching Word Sounds
Phonics
Spelling Recognition
Range of Information
Auditory Abstraction
Aud. Picture Meaning
Blend. Word Elements
Word Reversals
Aud. Verbal Concept.
Syllabication
Reversing Vis. Fig.
Tonal Intensity
Recog. Affixes-Roots
Pitch Discrimination
Visual Abstraction
Speed Word Perception
Speed Vis. Perception
Spatial Relations
Rhythm Discrimination
(Analysis Completed)

Note: All values
expressed in per cent

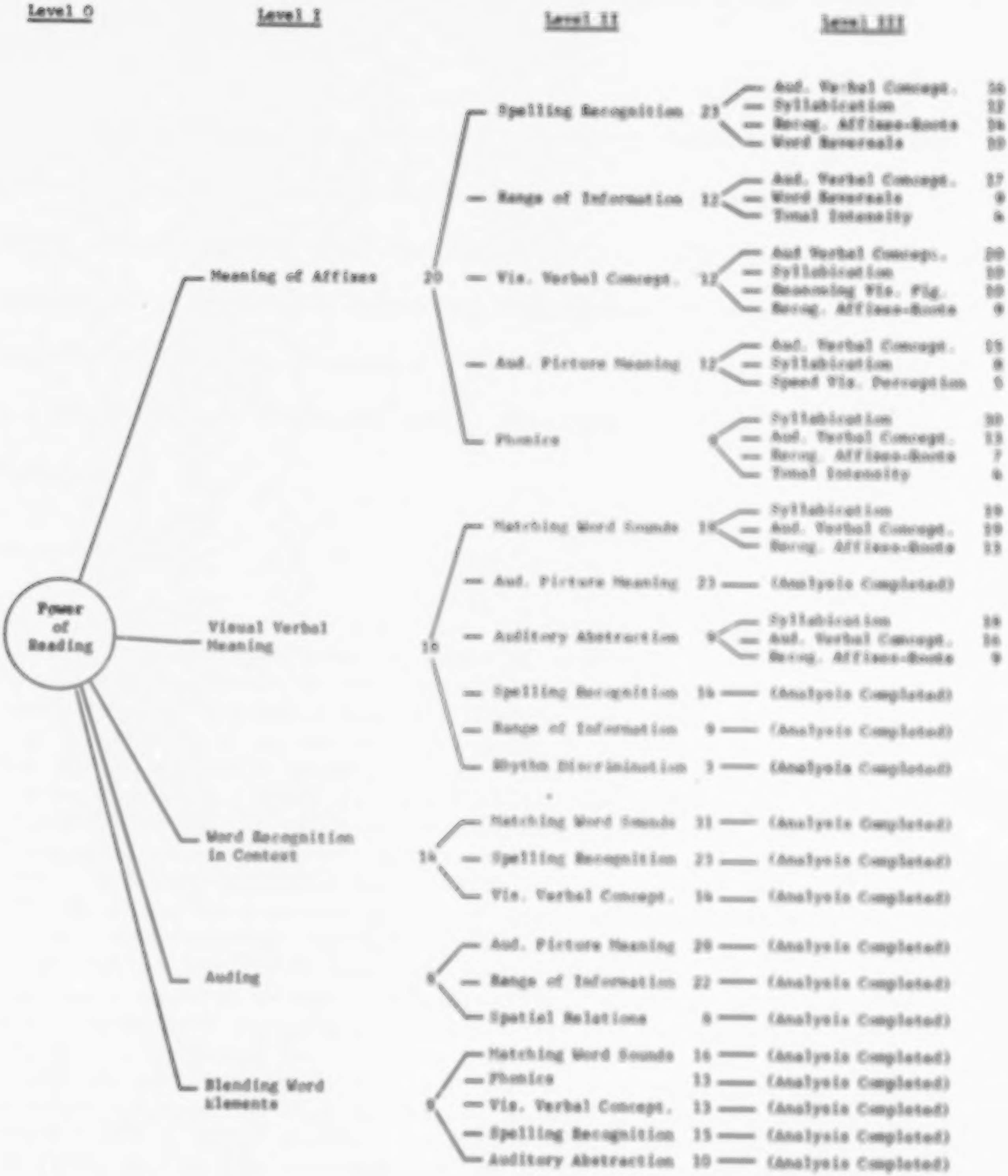
Figure 10. Flow Chart to Show Results of Substrata Analysis of Power of Reading, Fourth Grade Level

therefore, enter into the attainment of Meaning of Affixes.

(b) Visual Verbal Conceptualization: Blending Word Elements, 19%; Auditory Verbal Conceptualization, 13%; Syllabication, 12%; Reasoning with Visual Figures, 8%. At the third level, a variety of auditory and visual perceptual factors undergird the second substrata level predictors. The interesting finding is that the two conceptualization factors are reversed: Auditory Verbal Conceptualization, a first level factor at grade three, now underlies Visual Verbal Conceptualization. Apparently the pupils have so matured that they can mobilize a visual mode for conceptualization, which, in turn, can draw upon an auditory mode. Perhaps what permits this change is that blending word elements, syllabication, and reasoning in the visual mode have developed sufficiently so that pupils can function more adequately in the visual verbal conceptual mode, and this mode enables them to some degree to perform more adequately in Power of Reading.

(c) Matching Word Sounds: Spelling Recognition, 26%; Phonics, 17%; Blending Word Elements, 19%; Auditory Verbal Conceptualization, 7%. To sound out a whole word, therefore, an individual at the fourth grade level could mobilize spelling processes; knowledge of generalized letter sounds, despite grapheme differences ("kit" and "cat"); blending of sounds; and abstraction and generalization ability.

Grade 5. The following factors at the fifth grade level, as shown in Figure 11, are not much different from those at the fourth grade level: Meaning of Affixes, 20%; Visual Verbal Meaning, 18%; Word Recognition in Context, 16%; Auding, 8%; and Blending Word Elements, 9%. In contrast with the fourth grade, Visual Verbal Conceptualization did not precipitate


Level 0
Level I
Level II
Level III
Power of Reading
Meaning of Affixes
20
Spelling Recognition 23
Aud. Verbal Concept. 16
Syllabication 12
Recog. Affixes-Roots 14
Word Reversals 10
Range of Information 12
Aud. Verbal Concept. 17
Word Reversals 9
Tonal Intensity 6
Vis. Verbal Concept. 12
Aud Verbal Concept. 20
Syllabication 10
Reasoning Vis. Fig. 10
Recog. Affixes-Roots 9
Aud. Picture Meaning 12
Aud. Verbal Concept. 15
Syllabication 8
Speed Vis. Perception 5
Phonics 6
Syllabication 20
Aud. Verbal Concept. 13
Recog. Affixes-Roots 7
Tonal Intensity 6
Visual Verbal Meaning
16
Matching Word Sounds 16
Syllabication 19
Aud. Verbal Concept. 10
Recog. Affixes-Roots 13
Aud. Picture Meaning 23 (Analysis Completed)
Auditory Abstraction 9
Syllabication 19
Aud. Verbal Concept. 16
Recog. Affixes-Roots 9
Spelling Recognition 16 (Analysis Completed)
Range of Information 9 (Analysis Completed)
Rhythm Discrimination 3 (Analysis Completed)
Word Recognition in Context
14
Matching Word Sounds 31 (Analysis Completed)
Spelling Recognition 23 (Analysis Completed)
Vis. Verbal Concept. 16 (Analysis Completed)
Auding
8
Aud. Picture Meaning 20 (Analysis Completed)
Range of Information 22 (Analysis Completed)
Spatial Relations 6 (Analysis Completed)
Blending Word Elements
9
Matching Word Sounds 16 (Analysis Completed)
Phonics 13 (Analysis Completed)
Vis. Verbal Concept. 13 (Analysis Completed)
Spelling Recognition 15 (Analysis Completed)
Auditory Abstraction 10 (Analysis Completed)

Note: All values
expressed in per cent

Figure 11. Flow Chart to Show Results of Substrata Analysis of Power of Reading, Fifth Grade Level

at the first but only at the second level and Blending Word Elements which had been a second level factor at the fourth grade is now a first level factor.[1]

Grade 6. Figure 12 shows that only three factors accounted for 73 per cent of the variance in Power of Reading at the sixth grade level: Visual Verbal Meaning, 36%; Meaning of Affixes, 17%; and Matching Word Sounds, 20%. Therefore, individual differences in Power of Reading at the sixth grade level is attributable to word meaning, word meaning analysis, and the ability to sound out words, plus some unaccounted for or residual factors.

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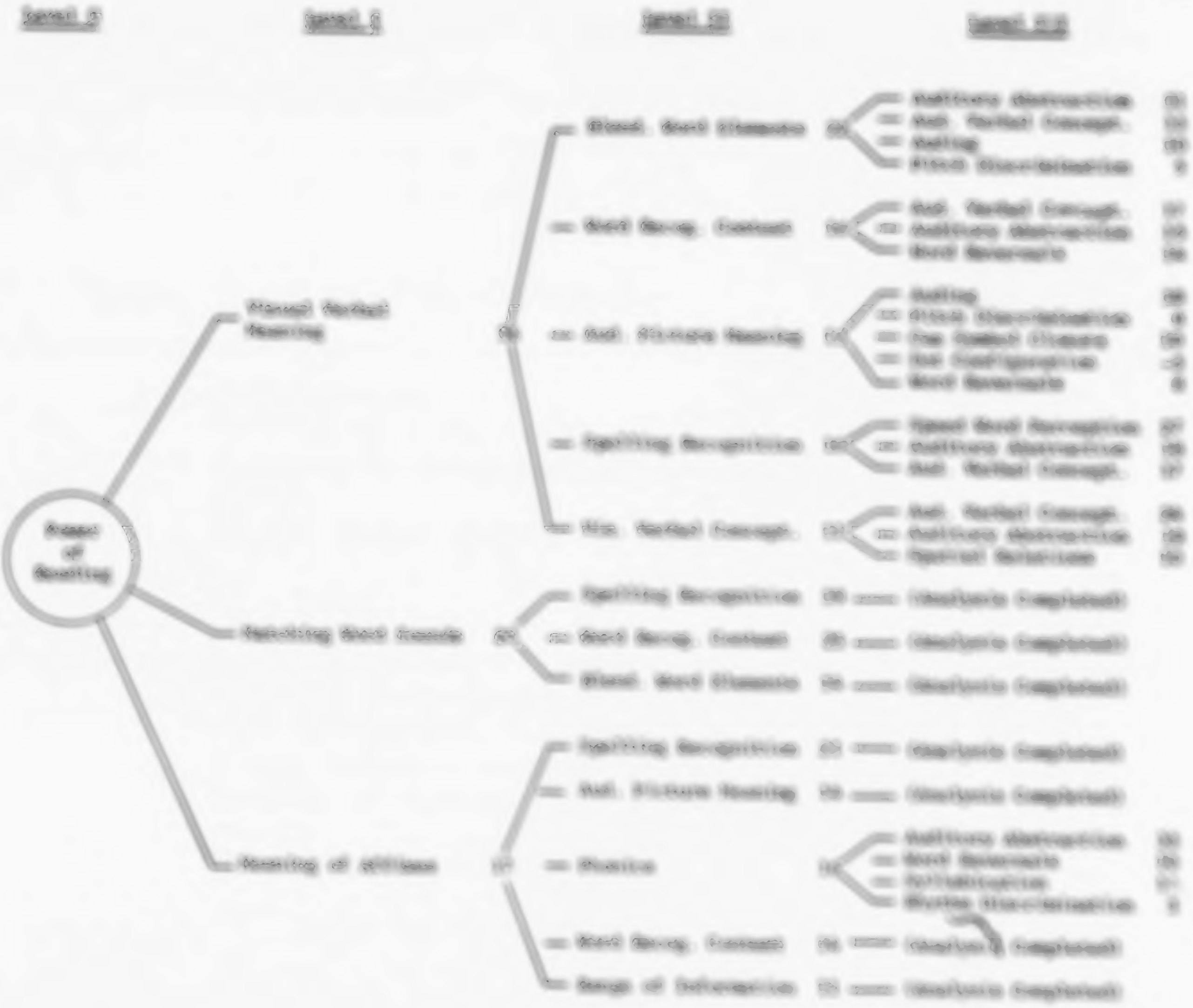
[1] Only at the fifth grade level does Blending Word Elements precipitate as a first level predictor of Power of Reading. At grades 3, 4, and 6, Matching Word Sounds is the primary level auditory word recognition subsystem for attaining Power of Reading. At these grade levels, Blending Word Elements is one of the subabilities that could be mobilized for attaining Matching Word Sounds. Although both factors tend to tap the same domains, there is nevertheless some differences in the abilities which they assess. Blending Word Elements emphasizes the ability to integrate auditory and visual components to obtain the sound of the whole word. However, Matching Word Sounds is a measure of the ability to sound out the whole word or the result of auditory-visual integration of word [illegible]rts. Consequently, improvement in Blending Word Elements would lead to increased ability in Matching Word Sounds. Therefore, an explanation for the temporary change in organizational position of these auditory word recognition subsystems is that there may be increased instructional emphasis and demand for utilization of auditory-visual word analysis and synthesis at the fifth grade level which results in a slight organizational shift in general working system for attaining Power of Reading while pupils are stressing these skills. As pupils become more proficient in their use of these skills and instructional emphasis shifts to some other aspect of reading, Matching Word Sounds, which has also improved and which can subsume Blending Word Elements in the hierarchical organization, resumes its position at the sixth grade level as a primary factor in the general working system for attaining Power of Reading.


Level 0
Level I
Level II
Level III
Power of Reading
Visual Verbal Meaning
Matching Word Sounds
Meaning of Affixes
Blend. Word Elements
Word Recog. Context
Aud. Picture Meaning
Spelling Recognition
Vis. Verbal Concept.
Auditory Abstraction
Aud. Verbal Concept.
Pitch Discrimination
Word Reversals
Dot Configuration
Speed Word Perception
Spatial Relations
Phonics
Syllabication
Rhythm Discrimination
Range of Information
(Analysis Completed)

Note: All values expressed in per cent

Figure 10. Flow Chart to Show Results of Substrata Analysis of Power of Reading, Sixth Grade Level

SUMMARY

Substrata analyses of Power of Reading in grades 3 through 6 revealed the following substrata sequences, identified by their first level predictors:

Grade	First Level Predictor	Per Cent Contribution to Variance in Power of Reading
3	Syllabication	7
	Word Recognition in Context	26
	Auditory Verbal Conceptualization	10
	Auding	7
	Visual Verbal Meaning	16
	Total	66 %
4	Matching Word Sounds	14
	Word Recognition in Context	12
	Visual Verbal Conceptualization	9
	Meaning of Affixes	11
	Auding	6
	Visual Verbal Meaning	19
	Total	71 %
5	Blending Word Elements	9
	Word Recognition in Context	14
	Meaning of Affixes	20
	Auding	8
	Visual Verbal Meaning	18
	Total	69 %
6	Matching Word Sounds	20
	Meaning of Affixes	17
	Visual Verbal Meaning	36
	Total	73 %

Power factors at the sixth grade accounted for more variance in Power of Reading while at the lower grades more factors accounted for less variance in Power of Reading. These results suggest that during the developmental range from grades 3 through 6 an integration has occurred in the general working system for attaining Power of Reading. Moreover, the quantitative and qualitative changes in substrata-factor organization accompanying development in Power of Reading confirm the major hypothesis of this study. These changes and the trends in development of substrata organization accompanying Speed and Power of Reading will be emphasized, interpreted, and discussed in the next chapter.

CHAPTER VII

SUBSTRATA-FACTOR REORGANIZATION ACCOMPANYING DEVELOPMENT IN SPEED AND POWER OF READING

The major developmental hypothesis of the substrata-factor theory of reading states that as an individual learns to read, he sequentially develops an hierarchically organized mental structure of interrelated neuropsychological subsystems. In response to the changing purposes of the reader and the demands of the task-stimuli, these subsystems are organized and reorganized or mobilized into a variety of working systems for attaining speed and power of reading. As a function of maturation, instruction, and experience, an individual's subsystems improve; consequently he can mobilize increasingly more effective working systems. However, improvement in speed and power of reading result not only from changes in the magnitude of substrata-factors which comprise an individual's subsystems, but also from the way in which his subsystems are organized. According to this hypothesis, two individuals could have quantitatively identical subsystems but one individual might still read better or more rapidly than the other because of a superior integration or a more mature organization of his subsystems.

Although the combination of subsystems that can be organized into a working system for attaining speed and power of reading may vary from individual to individual, at least at the high school level known groups of individuals, such as boys vs. girls or fast vs. slow readers, if they are to read at all, must mobilize certain necessary subsystems, whether these subsystems draw upon strengths or weaknesses in their substrata-factor repertoire. However, the working systems of known-groups of individuals, according to their unique patterns of strengths and weaknesses, vary quantitatively and qualitatively around this common structure (Holmes and Singer, 1961, 1964).

This evidence at the high school level is consistent with the hypothesis that there is for the average reader at each grade level a common structure or general working system for attaining speed and power of reading. Moreover, it would seem that this common structure would undergo systematic changes as individuals, in general, develop towards maturity in speed and power of reading. The purpose of this study, therefore, was to test this developmental hypothesis by determining whether substrata-factors at successively higher grade levels have systematic changes in magnitude and/or organizational position concomitant with improvement in speed of reading. Hence, the specific problem was to discover (1) what substrata-factors change and in what degree and (2) whether the general working system undergoes a reorganization in substrata-factors mobilized for general reading ability in grades 3 through 6.

The mass of data presented in the flow charts at each grade level in Chapters V and VI may have obfuscated rather than illuminated developmental trends. To make these trends explicit, diagrammatic models of substrata-factors accompanying development in Speed and Power of Reading were constructed by taking only Level I substrata-factors from each grade level for each major criterion and presenting them in flow charts. Each model is diagrammatically tantamount to a slice from either end of the schematic design shown in Figure 4b.

These models represent the substrata-factors which were derived from the correlation matrix at each grade level to account for over half the variance in speed and power of reading in the average group. The basic assumption is that the resulting change in organization of substrata-factors from grade to grade can be conceived of as a developmental model of a hierarchical working system that can be mobilized by the average reader as he improves in speed and power of reading in grades 3 through 6. Another way of stating the assumption is that the models represent a general developmental working system for attaining speed and power of reading around which individuals in grades 3 through 6 may vary as they mature in general reading ability.

In describing the model and inferring developmental changes in the organization of a hierarchical structure for attaining Speed and Power of Reading, some information that has already been presented in Chapters V and VI will of necessity be repeated. After each of these models has been discussed, some hierarchical changes in the development of the general working system will be shown. Essentially these hierarchical changes consist of systematic positional changes in substrata-factors concomitant with improvement in Speed and Power of Reading. The relationship between some theories of mental development and development in Speed and Power of Reading will conclude the chapter. The diagrammatic models for development of Speed and Power of Reading in grades 3 through 6 are shown in Figures 13 and 15, respectively. The model reveals (a) the first level factors which accounted for variance in Speed or Power of Reading at each grade level and (b) the developmental changes in substrata-factors that accompany improvement in Speed or Power of Reading from grades 3 through 6. In the left hand column of each figure are the substrata-factors or predictors for grade 3, followed in successive columns by the predictors for grades 4, 5, and 6. Adjacent to each predictor is its per cent contribution to the variance in Speed or Power of Reading for the particular grade level. At the bottom of each column is the variance in Speed or Power of Reading that was not accounted for, which must be attributable to variables other than those used in the construction of the model, such as functional oculomotor efficiency (Gilbert, 1953), flexibility (Laycock, 1958), speed of processing visual stimuli (Gilbert, 1959), mobilizers (Holmes, 1959), and biological support system (Davis, 1964) for Speed of Reading and temperament (Richardson, 1950), and verbal flexibility (Singer, 1965; Laycock, 1962) and mobilizers for Power of Reading (Holmes, 1959).

DEVELOPMENTAL MODEL FOR SPEED OF READING

Figure 13 shows that at the third grade level, 67 per cent of the variance in Speed of Reading was accounted for by the following five factors: Speed of Word Perception, 23%; Visual Verbal Meaning, 16%; Recognition of Affixes and Roots, 9%; Dot-Figure Ground Configuration, 5%; and Word Reversals, -2%. Speed of Word Perception, the ability to recognize words and phrases quickly, is a compound measure of speed and span of word recognition. Visual Verbal Meaning measures the ability to recognize a word and match it with a synonym. Recognition of Affixes and Roots is a test of ability to perceive commonly recurring and meaningful components of words. Dot-Figure Ground Configuration involves the ability to perceive quickly and accurately a letter or number embedded in a cloud of dots. Word Reversals, designed to assess perceptual control over word perception, requires rapid recognition of

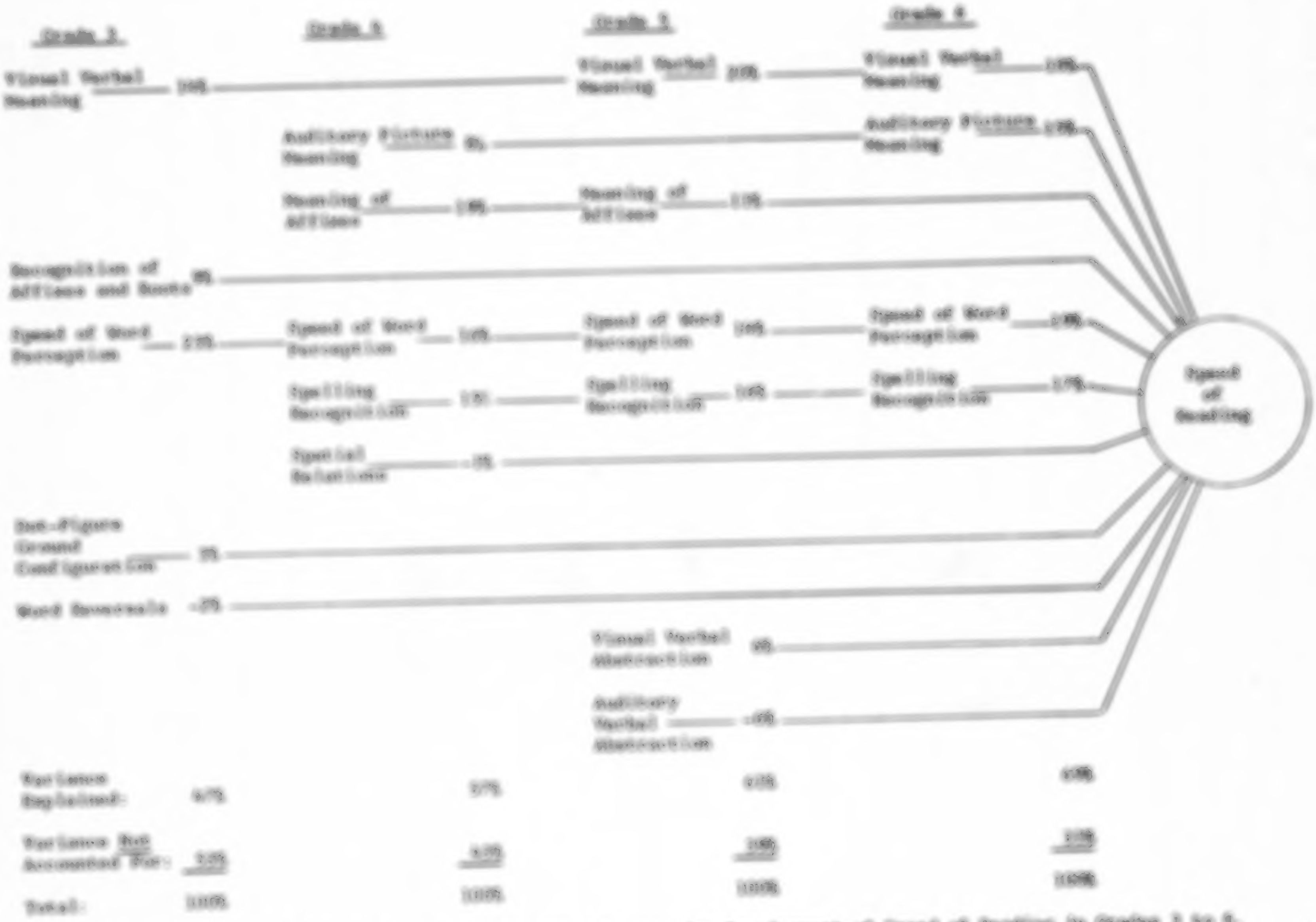

Grade 3
Grade 4
Grade 5
Grade 6
Visual Verbal Meaning
Auditory Picture Meaning
Meaning of Affixes
Recognition of Affixes and Roots
Speed of Word Perception
Spelling Recognition
Spatial Relations
Dot-Figure Ground Configuration
Word Reversals
Visual Verbal Abstraction
Auditory Verbal Abstraction
Speed of Reading
Variance Explained:
Variance Not Accounted For:
Total:
100%

Fig. 13. Diagrammatic Model of the Substrata Factors Accompanying Development of Speed of Reading in Grades 3 to 6. The model shows for each grade the first level substrata factors and their percent contribution to variance in Speed of Reading. The variance not accounted for is probably attributable to Functional Oculomotor Efficiency, Speed of Processing Visual Stimuli, Mobilizers, Biological Support System, and Verbal Flexibility.

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a multiple choice word spelled backwards, such as "time" and "emit."[1] At this grade level, individual differences in Speed of Reading are therefore dependent largely upon speed, control, and accuracy of visual perception of printed stimuli and to a lesser extent upon knowledge of word meanings and concepts they represent.

At the fourth grade level, five variables accounted for 57 per cent of the variance in Speed of Reading: Speed of Word Perception, 16%; Auditory Picture Meaning, 8%; Meaning of Affixes, 19%; Spelling Recognition, 15%; and Spatial Relations, -1%. Auditory Picture Meaning consists of associating a heard word with a picture or the attainment at least of a concrete level of word meaning. The ability to select a particular phrase that contains the meaning of a prefix or suffix attached to a given word was measured by Meaning of Affixes. Spelling Recognition is a multiple-choice type of spelling test that may be categorized as a visual word recognition ability and perhaps assesses visual memory images for words. The interesting result at this grade is the increase in variance accounted for by word meaning factors; this increment is part of a developmental trend which continues through grade 6.

At the next grade level, the following six variables accounted for 61 per cent of the variance in Speed of Reading: Speed of Word Perception, 14%; Visual Verbal Meaning, 20%; Meaning of Affixes, 11%; Spelling

---

[1] The small, negative contributions to variance made by Word Reversals at grade 3, Spatial Relations at grade 4, and Auditory Verbal Abstraction at grade 5 are interpreted as meaning that these factors may act as statistical suppressor-like purifiers. As such, they augment the combined contributions to variance which the other predictors make to Speed of Reading (Lubin, 1957; Holmes, 1959). However, for some individuals, their effect may also be to somewhat slow down Speed of Reading.

Recognition, 16%; Visual Verbal Abstraction, 6%; and Auditory Verbal Abstraction, -6%. The factors which precipitated at the fifth grade include two additional factors: Visual Verbal Abstraction, the ability to perceive the same stimulus word when embedded among varying letters, is analogous to the abstraction of a root word that has been perceived in several, somewhat different words; Auditory Verbal Abstraction is a similar ability for phonic elements, but in the fifth grade matrix has a suppressor-like effect, perhaps augmenting the contribution of the other factors by suppressing their phonic elements with the result that the organization of substrata-factors that are more visual in their modality can then function with greater efficiency for attaining Speed of Reading.

Only four factors accounted for 69 per cent of the variance in Speed of Reading at the sixth grade. The fact that fewer factors accounted for more of the variance at this grade than at the preceding grade level suggests that a more efficient integration has occurred in the substrata-factor organization for Speed of Reading. Another change is that 33% or almost half of the accounted for variance in Speed of Reading was distributed between two kinds of vocabulary factors: Visual Verbal Meaning, 18%, and Auditory Picture Meaning, 15%. Hence, both range and variety of vocabulary abilities are increasingly important in accounting for individual differences in development of Speed of Reading. The other two factors are Speed of Word Perception, 19% and Spelling Recognition, 17%. These factors deal with speed and span of word perception and visual memory images for words.

The faster reader can mobilize, when necessary, all the factors at the previous grade levels, but at the sixth grade level his range and variety of vocabulary abilities coupled with his speed and span of word perception and visual memory images for words give him his superiority. He can not only take in more words at once and process them more rapidly, but he can also mobilize the necessary word meanings, whether at the concrete or abstract levels and through the visual or auditory modalities, more adequately than the slower reader.

TRENDS IN THE DEVELOPMENTAL MODEL FOR SPEED OF READING

Four developmental trends can be discerned or inferred from the developmental model for Speed of Reading (See Figure 13):

(1) A gradual change occurs in substrata-factor organization from a predominance of variance attributable to such visual perceptual abilities at the third grade level as Speed of Word Perception, Recognition of Affixes and Roots, and Dot-Figure Ground Configuration to a more equitable distribution of variance among visual perceptual and word meaning factors at the sixth grade level.

(2) Although several auditory variables were in the matrix, only factors which were assessed by variables that could be categorized within the visual mode precipitated as positive, first level factors to account for variance in Speed of Reading in grades 3 to 6. Even when Auditory Verbal Abstraction, a factor logically classified as auditory did emerge in grade 5, it made a negative contribution to variance in Speed of Reading. This negative factor was interpreted as having a suppressor-like effect for auditory components in the general working system for Speed of Reading. It probably acts to suppress auditory components

so that the working system with a perceptual organization that is more visual in modality could then function more efficiently for rapid reading.

(3) Development of hierarchical organization or sequential integration and subordination of substrata-factors in the general working system can be inferred from the model and was also empirically demonstrated from changes in relationships among factors at the second and third substrata levels across grades 3 through 6 (Singer, 1965b). For example, Recognition of Affixes and Roots accounts directly for some of the variance in Speed of Reading at the third grade level, but only indirectly through other factors at higher grade levels. The development of an hierarchical organization in the general working system can be schematically perceived as a cross-section through the grades of the model shown in Figure 4b. More specifically, as shown in Figure 14, Recognition of Affixes and Roots precipitated in the third grade as a first level substrata-factor. At the fourth and fifth grade levels, Recognition of Affixes and Roots contributed through Phonics, a second level substrata-factor, to variance in Meaning of Affixes, which makes a direct contribution to variance in Speed of Reading. Finally, at the sixth grade level, Meaning of Affixes, as a second level substrata-factor, contributed to variance in Visual Verbal Meaning, which as a first level substrata-factor accounts directly for some of the variance in Speed of Reading.

(4) Speed of Word Perception and Verbal Meaning Factors precipitated

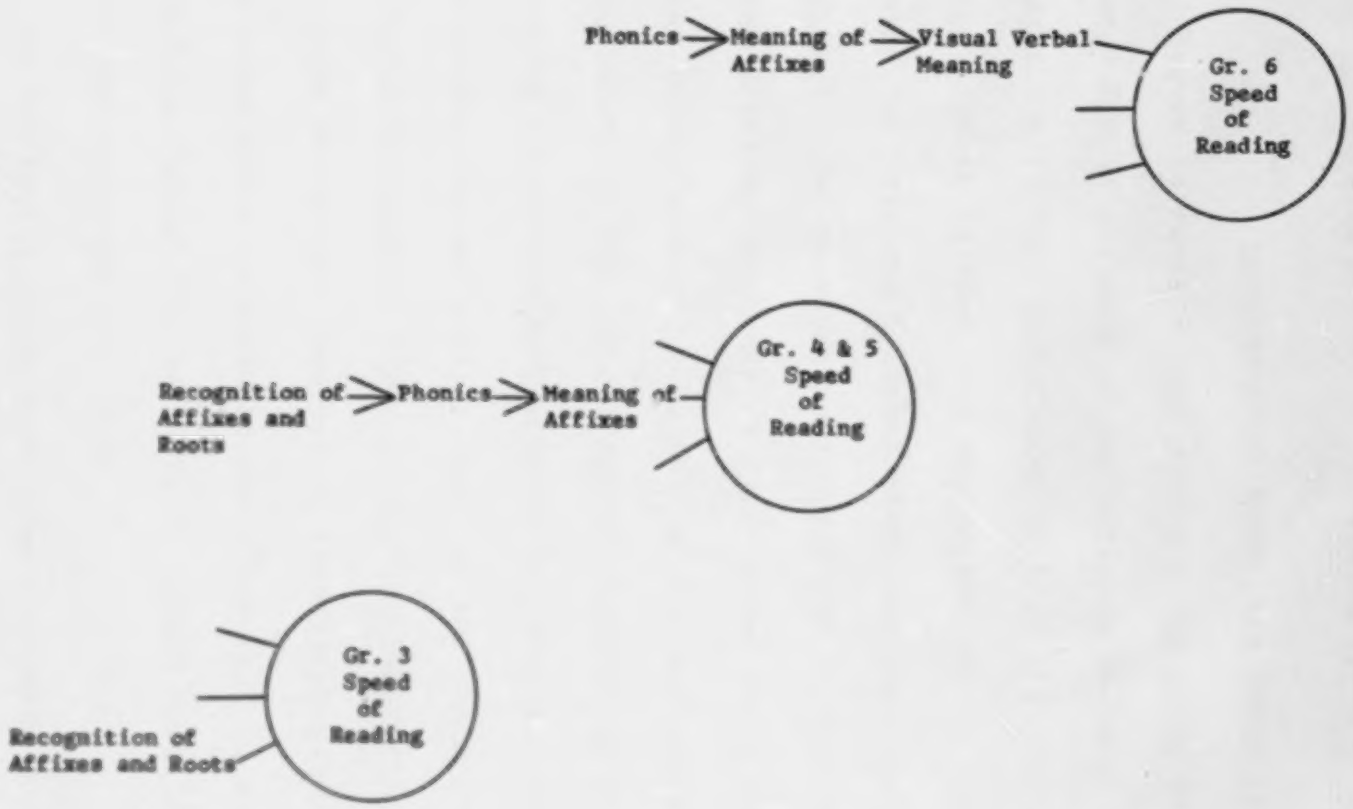
Phonics
Meaning of Affixes
Visual Verbal Meaning
Gr. 6 Speed of Reading
Recognition of Affixes and Roots
Phonics
Meaning of Affixes
Gr. 4 & 5 Speed of Reading
Recognition of Affixes and Roots
Gr. 3 Speed of Reading

Fig. 14. Developmental Integration of One Subsystem for Speed of Reading in Grades 3 Through 6. The figure shows that Recognition of Affixes and Roots accounts directly for some of the variance in Speed of Reading at the third grade level, but only indirectly through other factors at higher grade levels.

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as first level factors at each grade level; consequently, they have to be considered as necessary factors in the developmental working system for attaining Speed of Reading in grades 3 through 6.

DEVELOPMENTAL MODEL FOR POWER OF READING

Figure 15 reveals that at the third grade level, five factors accounted for 66 per cent of the variance in Power of Reading. Two word recognition factors contributed half of the predicted variance: Word Recognition in Context, the use of context to infer a missing word, accounted for 26%, and Syllabication, the application of syllabication rules to the division of words, accounted for another 7%. The remaining half of the predicted variance is distributed among the following three factors: Visual Verbal Meaning, 16%; Auding, 7%; and Auditory-Visual Verbal Conceptualization, 10%. These factors consist of knowledge of word meaning, listening comprehension for words and stories, and the formation and use of concepts, respectively. Thus, at the third grade level, half of the predicted variance in Power of Reading is attributable to word recognition abilities or factors involved in transforming visual verbal stimuli into meaningful mental processes; the other half is accounted for by association of meaning through the auditory or visual modality and the organization of these word meanings into ideas.

At the fourth grade level, the following quantitative changes (from grade 3) have occurred in the substrata-factors: Word Recognition in Context has declined to only 12% in contribution to variance in Power of Reading. Visual Verbal Meaning, however, has increased to 19% and Meaning of Affixes has emerged with 11% contribution to variance. But, Auding is approximately the same at 6%. Two other factors also precipitated

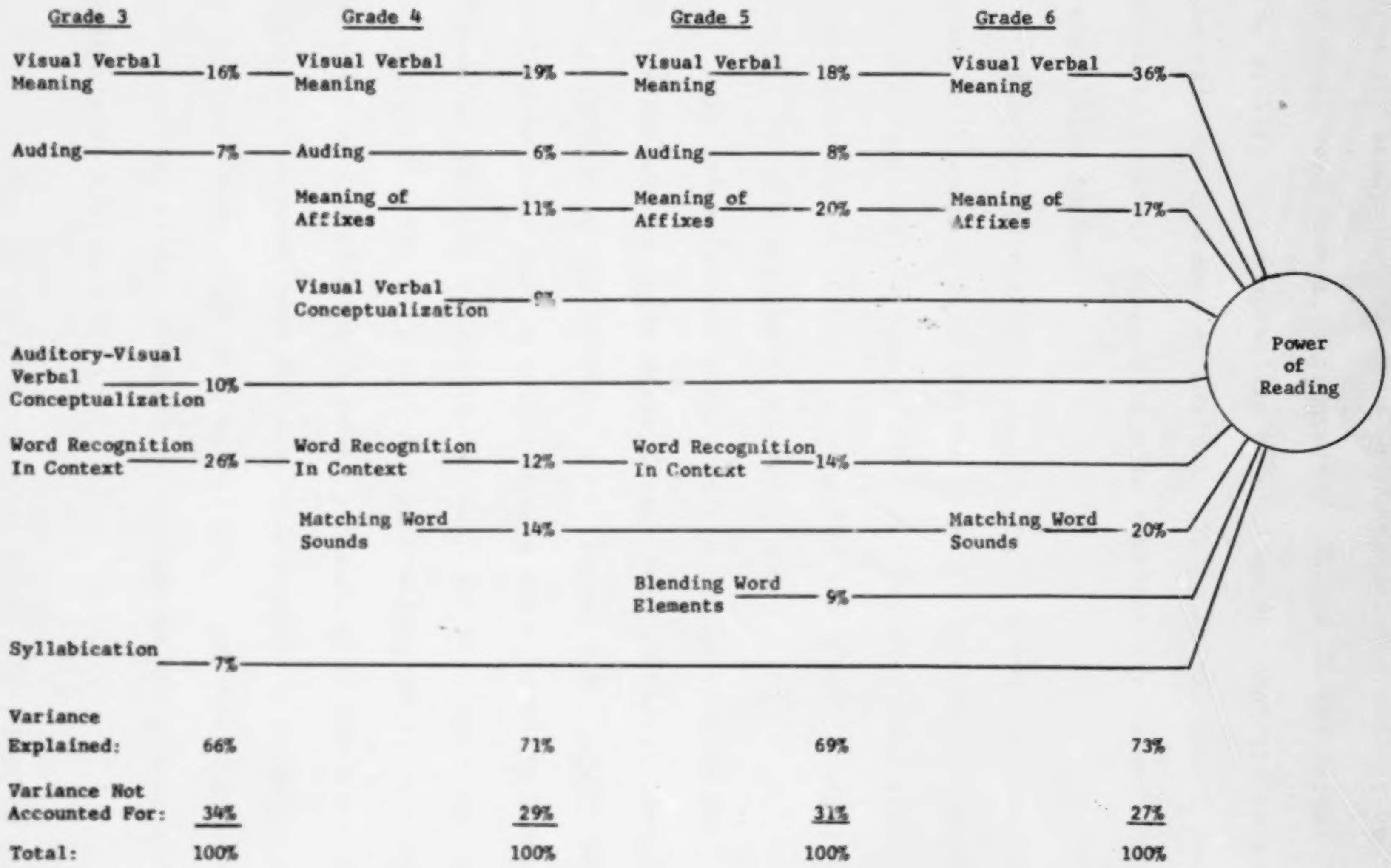
Grade 3
Grade 4
Grade 5
Grade 6
Visual Verbal Meaning 16%
Visual Verbal Meaning 19%
Visual Verbal Meaning 18%
Visual Verbal Meaning 36%
Auding 7%
Auding 6%
Auding 8%
Meaning of Affixes 11%
Meaning of Affixes 20%
Meaning of Affixes 17%
Visual Verbal Conceptualization 9%
Auditory-Visual Verbal Conceptualization 10%
Word Recognition In Context 26%
Word Recognition In Context 12%
Word Recognition In Context 14%
Matching Word Sounds 14%
Matching Word Sounds 20%
Blending Word Elements 9%
Syllabication 7%
Power of Reading
Variance Explained: 66% 71% 69% 73%
Variance Not Accounted For: 34% 29% 31% 27%
Total: 100% 100% 100% 100%

Fig. 15. Diagrammatic Model of the Substrata-Factors Accompanying Development of Power of Reading in Grades 3 to 6. The model shows for each grade the first level substrata factors and their per cent contributions to variance in Power of Reading. The variance not accounted for is probably attributable to Attitudinal Factors, Verbal Flexibility, and Mobilizers.

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from the analysis: Matching Word Sounds, the ability to recognize homonyms or whole word sounds, accounts for 14% and Visual Verbal Conceptualization, the ability to conceptualize printed words, contributes another 9% to the variance in Power of Reading. Thus, at the fourth grade level, variation in Power of Reading is more attributable to word meaning than to word recognition factors.

The trend discernible in the fourth grade continues at the fifth grade with another quantitative decrease in word recognition factors (Word Recognition in Context, 14% and Blending Word Elements, 9%) and another increment in word meaning factors (Visual Verbal Meaning, 18%; Auding, 8%; and Meaning of Affixes, 20%).

Only three factors accounted for 73 per cent of the variance in Power of Reading at the sixth grade level: Visual Verbal Meaning, 36%; Meaning of Affixes, 17%; and Matching Word Sounds, 20%. Again, word meaning and ability to infer word meanings that are not directly known through the visual or auditory modalities account for more variance in Power of Reading at the sixth grade than they did at previous grade levels. Success in intra-group competition in Power of Reading at the sixth grade level, therefore, depends upon skillfully transforming stimuli through the visual or auditory modalities into mental processes which can then be associated with meaning, either directly or through an analytical and synthesizing mediational system.

TRENDS IN THE DEVELOPMENTAL MODEL FOR POWER OF READING

The following trends can be gleaned or inferred from the developmental model for Power of Reading: (1) A combination of context clues and auditory word recognition processes are gradually integrated with other substrata-factors and mobilized throughout the development of the working system for attaining Power of Reading. (2) Both auding and visual verbal meaning systems are mobilized for attaining Power of Reading, but auding at the auditory-visual associational level becomes subordinately integrated with the visual verbal system after the fifth grade. (3) Individual differences at successively higher grade levels in Power of Reading are less attributable to word recognition processes and more associated with word meaning analysis and knowledge of word meanings and the concepts they represent. (4) Development of a hierarchy or a sequential integration of substrata-factors can be inferred from the model and was also empirically demonstrated by changes in relationships among factors at the second and third substrata levels across grades 3 through 6 (Chapter VI). This hierarchical development can be schematically perceived as a cross section through the grades of the model shown in Figure 4b. For an example, as shown in Figure 16, Syllabication accounted directly for some of the variance in Power of Reading at the third grade level. At the fourth grade level it contributed through Visual Verbal Conceptualization to variance in Power of Reading. At the fifth grade level, Visual Verbal Conceptualization accounted for some of the variance in Word Recognition in Context, which makes a direct contribution to variance in Power of Reading. Finally, at the sixth grade level, Word Recognition in Context contributed through Visual Verbal Meaning to variance in Power of Reading.

ELEMENTARY, HIGH SCHOOL, AND COLLEGE SUBSTRATA-FACTOR PATTERNS

A comparison of first level substrata-factors from the sixth grade of the above study and from previous investigations at the high school (Holmes and Singer, 1961) and college levels (Holmes, 1954), as shown

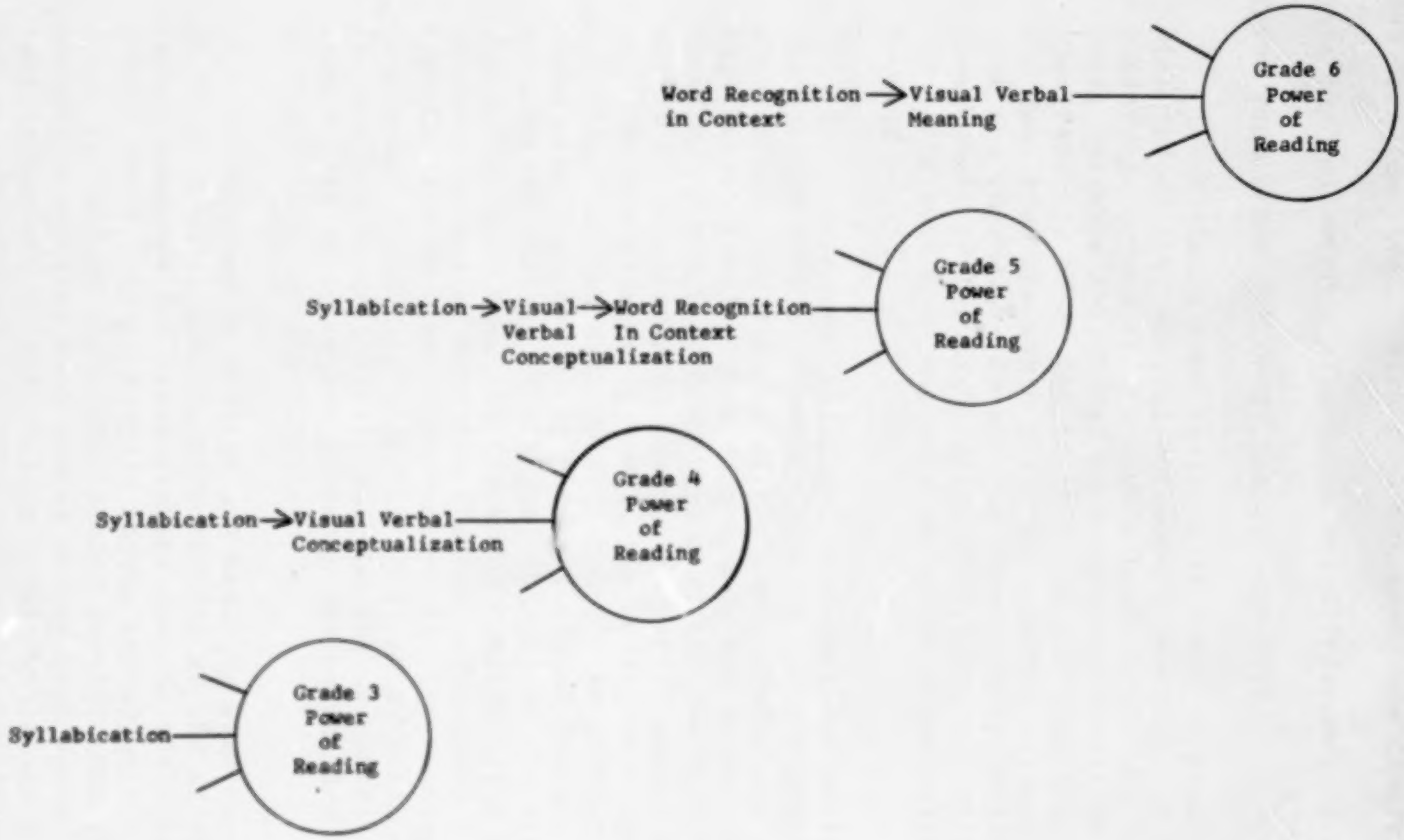
Word Recognition in Context
Visual Verbal Meaning
Grade 6 Power of Reading
Syllabication
Visual Verbal Conceptualization
Word Recognition In Context
Grade 5 Power of Reading
Syllabication
Visual Verbal Conceptualization
Grade 4 Power of Reading
Syllabication
Grade 3 Power of Reading

Figure 16. A Developmental Integration of One Subsystem for Power of Reading in Grades 3 through 6. The figure shows that Syllabication makes a direct contribution to variance in Power of Reading in Grade 3 but only an indirect contribution through other factors at Grades 4, 5, and 6.

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in Figure 17, can at best only suggest hypotheses for a longitudinal investigation, since neither the test batteries nor the subjects in these grades were identical. With this necessary qualification in mind, Figure 17 reveals the following similarities and differences in substrata-factor patterns from grade 6 through the college level:

> 1. Although some variance in Power of Reading may be distributed over several vocabulary measures, as shown in the substrata-factors at the high school level, the fact that the total variance attributed to vocabulary abilities increases significantly after the fifth grade and then remains approximately the same from the sixth grade through the college level suggests that the vocabulary domain has consequently attained a stage of development at the sixth grade that quantitatively approximates its contribution to variance in mature organization for Power of Reading.
>
> 2. Auding was included in the test batteries at all except the college levels. However, Auding did not precipitate at the sixth grade, but does so at the lower grades and again at the high school level. This discrepancy may be partly due to differences in the response systems of the two auding measures and partly to developmental changes in mental organization for reading. At the elementary level, the auding test consists of listening comprehension with responses to printed pictures and consequently seems to tap auditory-visual factors at a concrete or associational level (Singer, 1965c); at the high school level, the auding test measures listening comprehension with responses to verbally stated multiple choices. Therefore, the resulting hypothesis from these observations is that reading remains an "audiovisual verbal processing skill of symbolic reasoning" (Holmes and Singer, 1961), but the auding contribution to variance shifts at the sixth grade to auding ability at a more abstract level of organization.
>
> 3. Meaning of Affixes and Matching Word Sounds precipitated as first level substrata-factors only at the sixth grade, even though measures for these factors were in the matrices at each school level. These factors become subordinately integrated with other factors at the higher school levels. Knowledge of affixes becomes integrated with Auding at the high school level and Vocabulary in Context at the college level, while auditory processes become subordinated to auding and visual vocabulary factors at the higher levels.

To summarize: this comparison has suggested the following hypotheses: (1) subordinate integration within factors mobilized for Power of Reading

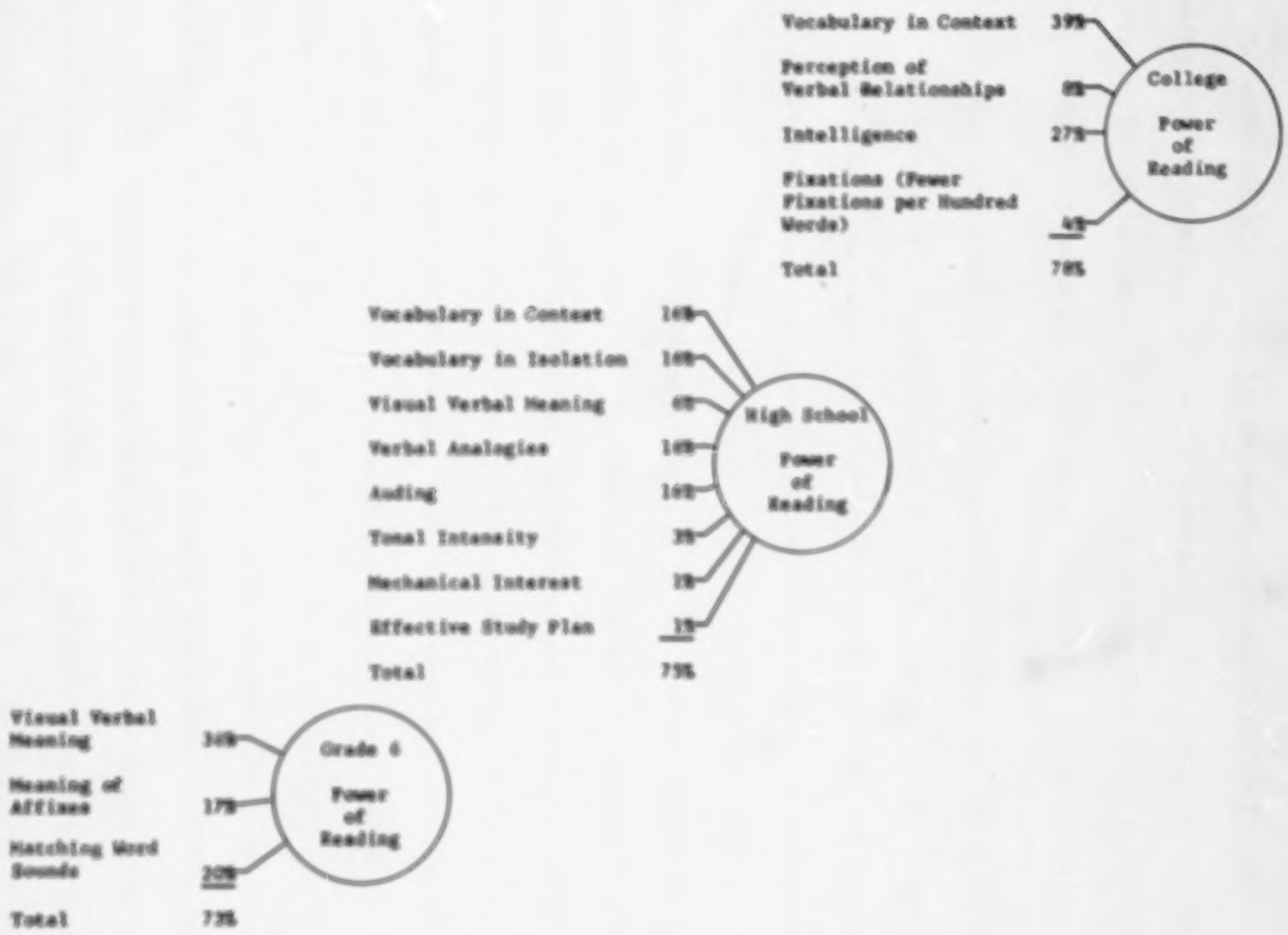
Vocabulary in Context 39%
Perception of Verbal Relationships 8%
Intelligence 27%
Fixations (Fewer Fixations per Hundred Words) 4%
Total 78%
College
Power of Reading
Vocabulary in Context 16%
Vocabulary in Isolation 16%
Visual Verbal Meaning 6%
Verbal Analogies 16%
Auding 16%
Tonal Intensity 3%
Mechanical Interest 3%
Effective Study Plan 3%
Total 79%
High School
Power of Reading
Visual Verbal Meaning 34%
Meaning of Affixes 17%
Matching Word Sounds 22%
Total 73%
Grade 6
Power of Reading

Fig. 17. First Level Substrata Factors and Their Per Cent Contributions to Variance in Power of Reading at the Sixth Grade, High School, and College Levels.

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continues throughout the grades, (2) at the sixth grade level, a stage characteristic of mature organization for Power of Reading has occurred in the vocabulary domain, (3) between elementary and high school levels, auding shifts from a concrete to a more abstract level of organization in contribution to variance in Power of Reading, and (4) the visual modality becomes dominant over the auditory in processing input stimuli.

RELATIONSHIP BETWEEN DEVELOPMENT OF INTELLIGENCE AND POWER OF READING

The following explanations of the development of intelligence are consistent with the substrata-factor theory of reading and may help explain some developmental changes in factor patterns for attaining power of reading: (1) Bruner and Olver (1963, p. 133) found that level of conceptualization in elementary school is an inverse function of the difficulty of the concept. For example, an individual could attain generalizability and economy in information processing by using the superordinating concept of "fruit" for integrating the relatively easy elements, "orange" and "banana." But, as elements increasingly more distant on a continuum from concrete to abstract were added until the elements finally exceeded the capability of an individual to integrate them by means of superordination, he would resort to a less mature type of organization, sometimes simply linking the elements of the concept into a story, much as a reader who could not answer a question on the central thought of a passage might reply by merely repeating what he had read. Bruner and Olver then theorized that in the growth of intelligence, strategies develop for encoding information in simpler form, connecting this encoded information with other information already encoded, and maximizing the possibility of combinatorial operations for grouping and regrouping information. In general, therefore, an older individual is less complex than a younger person in the sense that the older individual's information is more organized, interconnected, and capable of reorganization. Likewise in the substrata-factor theory of reading, factors or subsystems of information are hierarchically organized and interrelated with other subsystems, which are mobilized into working systems according to the purposes of the reader and the demands of the task. When the task becomes increasingly difficult, the motivated individual may respond by mobilizing a more complex working system, consisting of some factors which had developed at an earlier stage; for example, an individual might resort to reading difficult material aloud, but for easier material he would use a more mature visual processing subsystem. (2) Piaget (Inhelder and Piaget, 1958)[1] has categorized mental development as progressing through three emerging levels of organization which can be accelerated or delayed by environmental factors but is mostly biologically determined: (a) The sensorimotor stage consists of operations that require action on objects, but the action is not accompanied by simultaneous mental representation; (b) a concrete stage emerges about age 6 that is characterized by simultaneous mental representation, but in this stage the individual is not yet able to carry out more than one simultaneous operation, such as reversibility or conservation or transitivity; and (c) a stage of formal operations, beginning about age 12 and reaching a peak at age 15, at which the individual becomes capable of generating all hypothetical combinatorial possibilities in the solution of a problem. Passage from an "inferior" to a "superior" stage is equivalent to an integration in which the inferior serves as a base for the superior and becomes part of the superior. Piaget's theory of developmental stages may explain the changes in factor patterns that emerge about the sixth grade: the average sixth grader may be passing from a concrete to the more abstract, formal stage of development. (c) Closely related to the developmental pattern of changes that accompany improvement in Power of Reading is the conclusion on the growth of intelligence reached by Bayley (1955, p. 807) in her monumental longitudinal study: "Intelligence...appears to be a dynamic succession of developing functions with the more advanced and complex functions in the hierarchy depending on the prior maturing of earlier, simpler ones."

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[1] Inhelder (1963) has written a brief, but excellent summary of Piaget's stages of mental development.

Although the structure of intelligence and Power of Reading have some degree of communality (Holmes, 1964), the factors typically measured by intelligence and reading tests are not identical. In the working system mobilized for attaining Power of Reading some subsystems, such as word recognition, are tapped which would not necessarily be mobilized for performance on an individual test of intelligence, even though conceptualization abilities may enter into the acquisition of the word recognition system (Singer, 1960). Another way of stating the argument is simply to point out that although an individual may be bright, he still has to learn to read. This is tantamount to saying that he must acquire the necessary hierarchy of subsystems and learn to mobilize them into an integrated working system for attaining Power of Reading.

SUMMARY

Developmental changes in substrata-factor organization accompanying improvement in Speed and Power of Reading were explicated by constructing models based upon first level factors which had precipitated from substrata analyses of Speed and Power of Reading in grade levels 3 through 6.

From the model for Speed of Reading, these four developmental trends were inferred:

(1) A gradual change occurs in the substrata-factor organization for Speed of Reading from a predominance of variance attributable to visual perceptual abilities at the third grade level to a more equitable distribution of variance among visual perceptual and word meaning factors at the sixth grade level.

(2) Only factors tapped by variables that could be logically categorized in the visual modality precipitated in grade levels 3 through 6 as positive, primary level factors to account for variance in Speed of Reading.

(3) Development of an hierarchical organization in the general working system was implicit in some sequential changes in relationships among first, second, and third level substrata-factors across grades 3 through 6, and

(4) Speed of Word Perception and verbal meaning factors were found to be necessary factors in the developmental working system for attaining Speed of Reading in grades 3 through 6 because they precipitated as first level factors at each of these grade levels.

These four trends were implicit in the developmental model constructed for Power of Reading:

(1) A combination of context clues and auditory word recognition processes are gradually integrated with other substrata-factors and mobilized throughout the development of the working system for attaining Power of Reading in grades 3 through 6.

(2) Both auding and visual verbal meaning subsystems are mobilized for attaining Power of Reading, but auding at the auditory-visual association level becomes subordinately integrated with the visual verbal system after the fifth grade. It was hypothesized that after the fifth grade a more centrally-determined auding subsystem enters into Power of Reading.

(3) Individual differences, in general, at successively higher grade levels are less and less attributable to word recognition processes and more associated with word meaning analysis and knowledge of word meanings and the concepts they represent.

(4) Development of a hierarchical organization in the general working system for attaining Power of Reading was inferred from sequential changes in substrata-factors at the first, second, and third substrata levels.

Thus, reorganization in the general working systems for attaining Speed and Power of Reading does occur in the average individual across grades 3 through 6. Because quantitative and qualitative changes in substrata-factor organization accompany improvement in Speed and Power of Reading in grades 3 through 6, the major hypothesis of this investigation, has been confirmed.

The minor hypothesis was also confirmed, but not quite in the way expected. The data revealed that the minor hypothesis would have to be differentiated with respect to Speed and Power of Reading. Consequently, a more sophisticated way of stating the minor hypothesis is that in reading for Speed, the intermediate grader tends to mobilize a working system undergirded primarily by visual processes; in reading for Power, his working system is organized to utilize both auditory and visual subsystems, but after the fifth grade a modality shift occurs in which auding at an auditory-visual association level becomes integrated with and subordinate to his visual verbal subsystem. Thus, in confirmation of previous findings at the fourth grade level (Singer, 1960), a shift in the reading task from either Speed to Power or vice versa at each grade level from 3 through 6 would necessitate a change in the mental organization of the reader. The qualitative and quantitative differences that were discovered in the development of those subabilities and capacities subsumed within the working systems for attaining Speed and Power of Reading appear to be a function of (a) the difficulty of the reading material in relation to the average individual's level of development in his general working system and (b) the varied purposes of the reader. For both Speed and Power of Reading in grades 3 through 6, the average individual has developed and continues to develop a complex of ideational processes to bear upon the reading task.

CHAPTER VIII

KNOWN-GROUP DIFFERENCES IN SUBSTRATA SELECTED VARIABLES

The purpose of this chapter is to ascertain the relative rate of development of substrata selected variables in the average individual in such known-groups as (a) Grade Level, (b) Boys vs. Girls, (c) Slowest vs. Fastest Readers, and (d) Least vs. Most Powerful Readers. The results of this investigation of known-groups have both theoretical and practical value. In the theoretical realm, the following hypothesis of the substrata-factor theory will be tested: the relative rate of development in Speed and Power of Reading is functionally associated with differences between the average individuals of the known-groups in magnitude of substrata selected variables. Specifically, the results will reveal which variables that are, in general, related to superior rate of development in Speed and Power of Reading in the known-groups. In the practical realm, the results can be used for evaluating the pattern of development of an individual's general working system for attaining Speed and Power of Reading (Singer, 1962, 1965a).

ANALYSIS OF THE DATA

The test data on each variable for all 927 pupils in the four grades were transformed into standard scores with a common mean of 50 and standard deviation of 10. Statistical significance of differences between means were computed for each variable by (a) grade, (b) sex within grades, (c) upper and lower 27 per cent of each grade ranked on Speed of Reading, and (d) upper and lower 27 per cent of each grade ranked on Power of Reading.

The mean standard scores of each of these groups were then plotted on psychographs.

Because the data depicted in the psychographs are in standard score form, it is possible to visually compare differences between and within each grade level on each variable. Consequently, the psychographs reveal (a) rate of development of the average individual in each known-group and (b) pattern of development on these variables within the average individual of each group at a particular grade level and (c) magnitude of differences between the average individuals of these known-groups on each variable at each grade level.

For each known-group, a psychograph based upon the results of analysis of correspondence (Holmes, 1954) will be depicted. This analysis consists of a test of the significance of difference between means of the known-groups on each variable. Then substrata analysis will be integrated with analysis of correspondence by simply plotting psychographs of the known-groups on only those variables that have been selected by substrata analysis as representative of first level substrata-factors that accompany development in Speed and Power of Reading in grades 3 through 6. These substrata selected variables have already been shown in Figures 13 and 15 on pages 107 and 115, respectively.

PSYCHOGRAPHS OF KNOWN-GROUPS

Grade Level. The psychograph of the average individual in grades 3, 4, 5, and 6 has already been presented in Figure 3, page 53. The raw and standard scores for this psychograph are shown in Tables 4 and 5 on pages 51 and 52, respectively. The psychographs of the average individual in grades 3 through 6 on first level substrata selected variables for Speed and Power of Reading are shown in Figures 18 and 19, respectively. The variables shown in Figure 3 are substantially intercorrelated. More parsimonious sets of variables for evaluating development of a general working system for attaining Speed and Power of Reading in the average individual in grades 3 through 6 are depicted in Figures 18 and 19, respectively. The variables which are listed in these psychographs have been selected by substrata analysis as first level predictors of Speed and Power of Reading, respectively, in grades 3 through 6.

Inspection of Figure 18 shows that eleven variables are representative of the factors that are most closely related to the development of Speed of Reading in the average individual in grades 3 through 6. These variables could be broadly categorized as word meaning (Visual Verbal Meaning and Meaning of Affixes), visual verbal perception (Speed of Word Perception, Recognition of Affixes and Roots, Spelling Recognition), speed of visual perception (Dot-Figure Ground Configuration, Spatial Relations, and Word Reversals). Two suppressor variables, Word Reversals and Auditory Verbal Abstraction, were interpreted as statistically contributing to control of and purification of visual verbal perception. Therefore, the dominant emphasis in development of Speed of Reading in grades 3 through 6 in the average individual is on word meaning, speed and span of whole word recognition, and speed and control of visual verbal perception.

Modality dominance in development of Speed of Reading in grades 3 through 6 is primarily visual. No auditory variable at any level of organization on the continuum from peripheral (auditory perception) to central processes (auding) was selected as a first level positive predictor

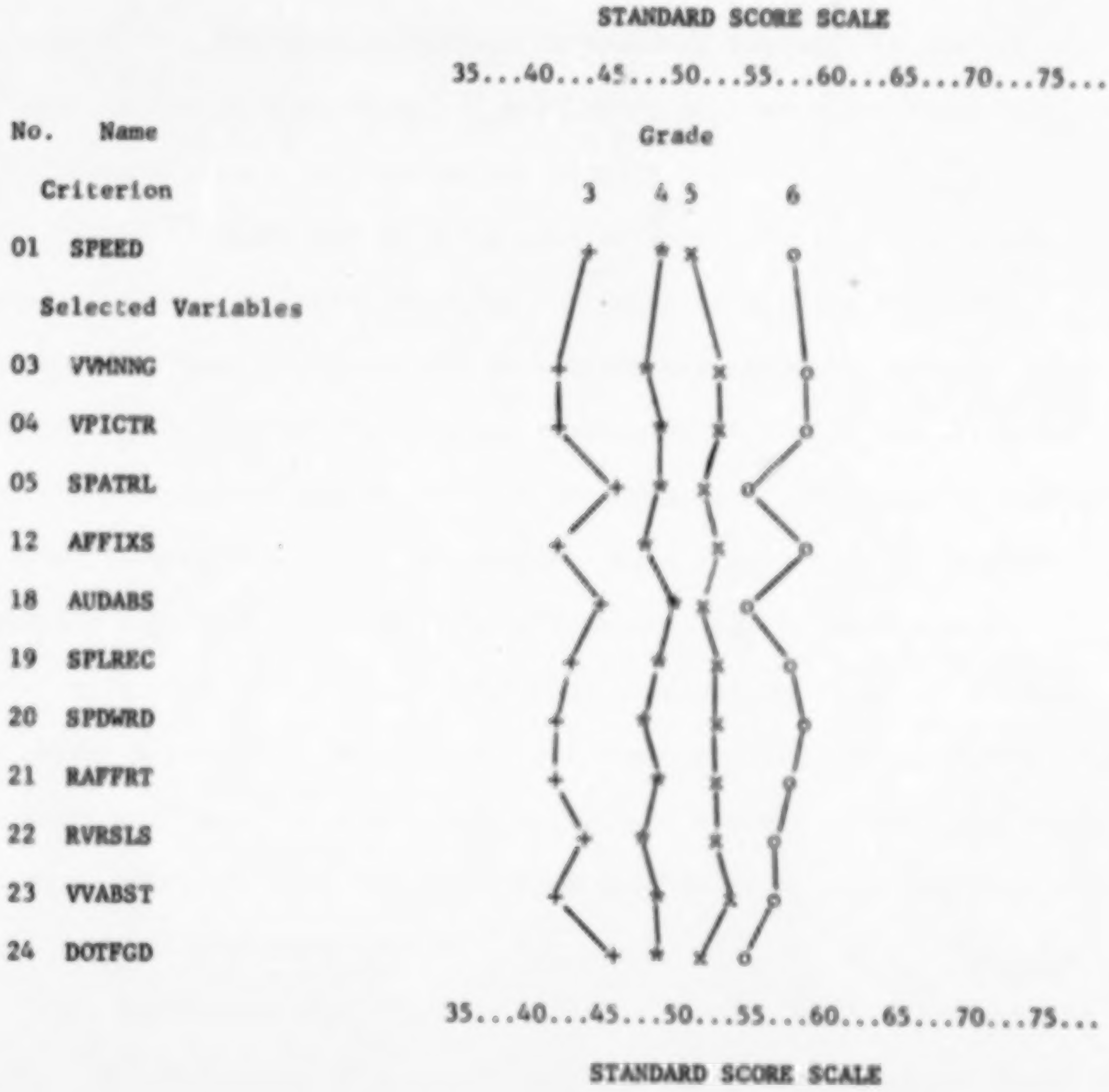

Figure 18. Psychograph of mean standard scores of Level I substrata selected variables for Speed of Reading for grades 3 through 6. The standard scores are based on a mean of 50 and a standard deviation of 10, determined from the total sample of 927 pupils in grades 3 through 6. The groups are compared on first level predictors for Speed of Reading at each grade, as shown in Figure 13. These variables, in the order listed in the figure, are: Speed of Reading, Visual Verbal Meaning, Auditory Picture Meaning, Spatial Relations, Meaning of Affixes, Auditory Verbal Abstraction, Spelling Recognition, Speed of Word Perception, Recognition of Affixes and Roots, Word Reversals, Visual Verbal Abstraction, and Dot-Figure Ground Configuration.

of Speed of Reading in the intermediate grades. If there is a gradient shift in modality dominance from auditory to visual in factors which account for individual differences in Speed of Reading, then according to the results of this study, it must occur at some other level than the intermediate grades, perhaps at the primary level.

Figure 19 shows the relative rate of development of nine first level substrata selected variables for _Power of Reading_ in grades 3 through 6. These variables may be categorized into four groups: word meaning (Visual Verbal Meaning and Meaning of Affixes), reasoning-in-context (Visual and Auditory Verbal Conceptualization), central auditory ability (Auding), and word recognition (Word Recognition in Context, Matching Word Sounds, Blending Word Elements, and Syllabication). Apparently then, the average individual in attaining Power of Reading in grades 3 through 6 develops a first level general working system that includes word meaning, reasoning-in-context, and word recognition subsystems. Moreover, his working system also receives some interfacilitation from central auditory processes.

The hypothesis that there is a shift in modality from auditory to visual in development of a general working system for attaining Power of Reading during the intermediate grades obtains some support from the data in Figure 19: Visual Verbal Meaning has gained in rate of development over Auding at the sixth grade level. This evidence is consistent with the substrata analysis which revealed that at the sixth grade level Auding became integrated and was subsumed by Visual Verbal Meaning.

Comparison of the psychograph for the average reader in grades 3 through 6, Figure 3, reveals that in almost every variable there is a

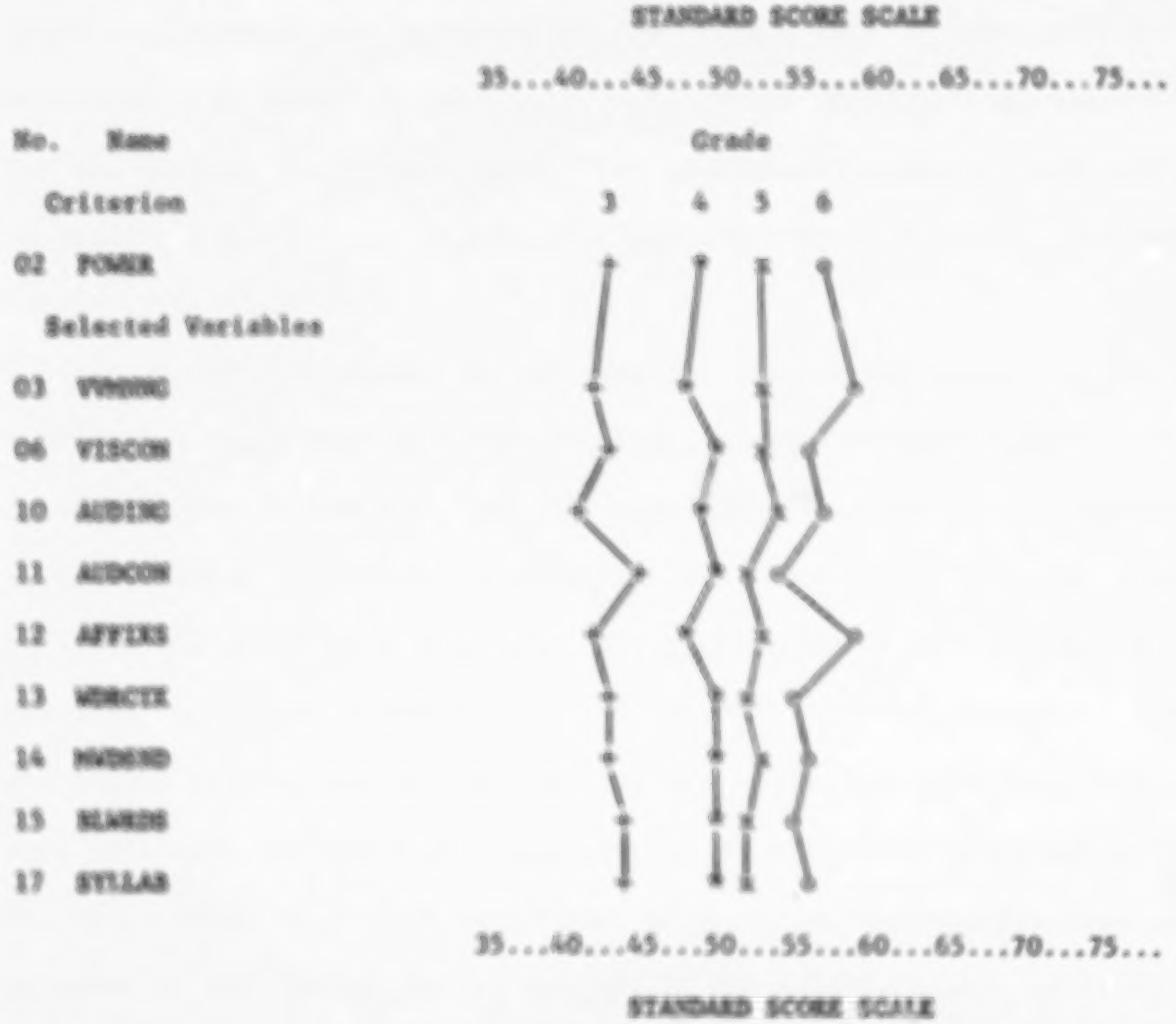

Figure 19. Psychograph of mean standard scores of Level I substrata selected variables for Power of Reading for grades 3 through 6. The standard scores are based on a mean of 50 and a standard deviation of 10, determined from the total sample of 927 pupils in grades 3 through 6. The groups are compared on first level predictors for Power of Reading at each grade, as shown in Figure 15. These variables, in the order listed in the figure are: Power of Reading, Visual Verbal Meaning, Visual Verbal Conceptualization, Auding, Auditory Verbal Conceptualization, Meaning of Affixes, Word Recognition in Context, Matching Word Sounds, Blending Word Elements, and Syllabication.

statistically significant increment in mean standard scores from grade to grade. Hence a concomitant of normal improvement in speed and power of reading throughout the intermediate grades is a more or less uniform development of subskills and capacities. These developmental increments for the average reader may result from comprehensiveness of instruction in reading together with a generally uniform rate of cortical development and interfacilitation.

In theoretical terms, the results for the average reader in grades 3 through 6 imply that development of the general working system of the average reader at least through the intermediate grades can be represented by quantitative increments in subskills and capacities. Such improvement in speed and power of reading may only partly depend upon the ability to mobilize subsystems composed of quantitatively superior elements. Faster and better reading during the intermediate grades may also stem from a more effective and efficient organization of subsystems and greater flexibility in mobilizing these subsystems to meet the increasingly more mature purposes of the reader and the demands of the reading task. In fact, as shown in the developmental models in Figures 13, 14, 15, and 16 in Chapter VII, developmental integration and hierarchical reorganization of substrata-factors that can be mobilized by the average reader for attaining Speed and Power of Reading do occur during the intermediate grades.

However, a particular pupil's profile or psychograph during grades 3 through 6 may vary somewhat from this relatively uniform pattern of development. Some variation in the individual's pattern of development in reading may be attributable to normal interindividual and intraindividual differences in a variety of causal conditions, such as asynchronous rates of maturation of mental functions (Bayley, 1949). Individual differences in pattern of development of general reading ability must of course be taken into account in designing reading instruction. But, a significant departure from the general pattern of development from the average or from one of the known-groups suggests the necessity for an individual diagnosis to determine whether there are causal deficiencies that may be remedied (Singer, 1962, 1965a).

Boys vs. Girls. In the United States, sex differences in reading achievement consistently favor girls throughout the elementary grades (Holmes and Singer, 1964). Even at the reading readiness level, girls on the average score higher than boys, particularly on the visual word discrimination subtest of Gates Reading Readiness (Balow, 1963). This superiority is maintained from grades 2 through 8 on speed, comprehension, and vocabulary (Gates, 1961). But, in reading achievement at the elementary school level in Wiesbaden, Germany, boys in general are superior to girls (Preston, 1962). Although current research findings seem to support an environmental explanation of sex differences in reading, the evidence is still not conclusive. For example, the reading development of Wiesbaden girls could have been sufficiently retarded by differential educational treatment or cultural influences to have more than off-set any potentially superior biological tendency or rapidity in maturational rate of girls.

Previous investigations have only been concerned with relating causal determinants of sex differences to the criterion measures, speed or power of reading. The question posed for this study is whether such causal determinants, whatever they may be, influence development of the general working system of subskills and capacities that are related to Speed and

Power of Reading. To answer this question, boys and girls within each grade level were contrasted on each variable in the test battery.

Mean standard scores of boys vs. girls on Speed and Power of Reading at each grade level are shown in the psychograph in Figure 20.[1] But on the independent variables, only the mean standard scores on which boys vs. girls within a grade are significantly different at least at the five per cent level, as shown in Table 9, are depicted in the psychograph.

Analysis of the results reveals that at each grade level, girls are superior to boys not only in Speed and Power of Reading, but also in many other variables. At the third grade level, girls are not only significantly better than boys in Speed and Power of Reading but also on certain word recognition and visual verbal conceptualization variables. At the fourth grade level, girls are still superior to boys in Speed and Power of Reading, but the difference in Speed of Reading is not statistically significant. However, girls are superior to boys on more independent variables, including not only word recognition but also visual verbal meaning variables. At the fifth grade, girls are still superior to boys in Speed and Power of Reading, but the difference between them is now not significant in Power of Reading. Although fifth grade girls are significantly better on almost all word recognition variables, fifth grade boys are significantly better on Auding. But, the difference between the groups is no longer significant for visual verbal meaning. At the sixth grade, the magnitude of differences

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[1] Standard deviation and mean raw scores of boys vs. girls at each grade level on all the variables assessed in this study are located in Table C in the Appendix.

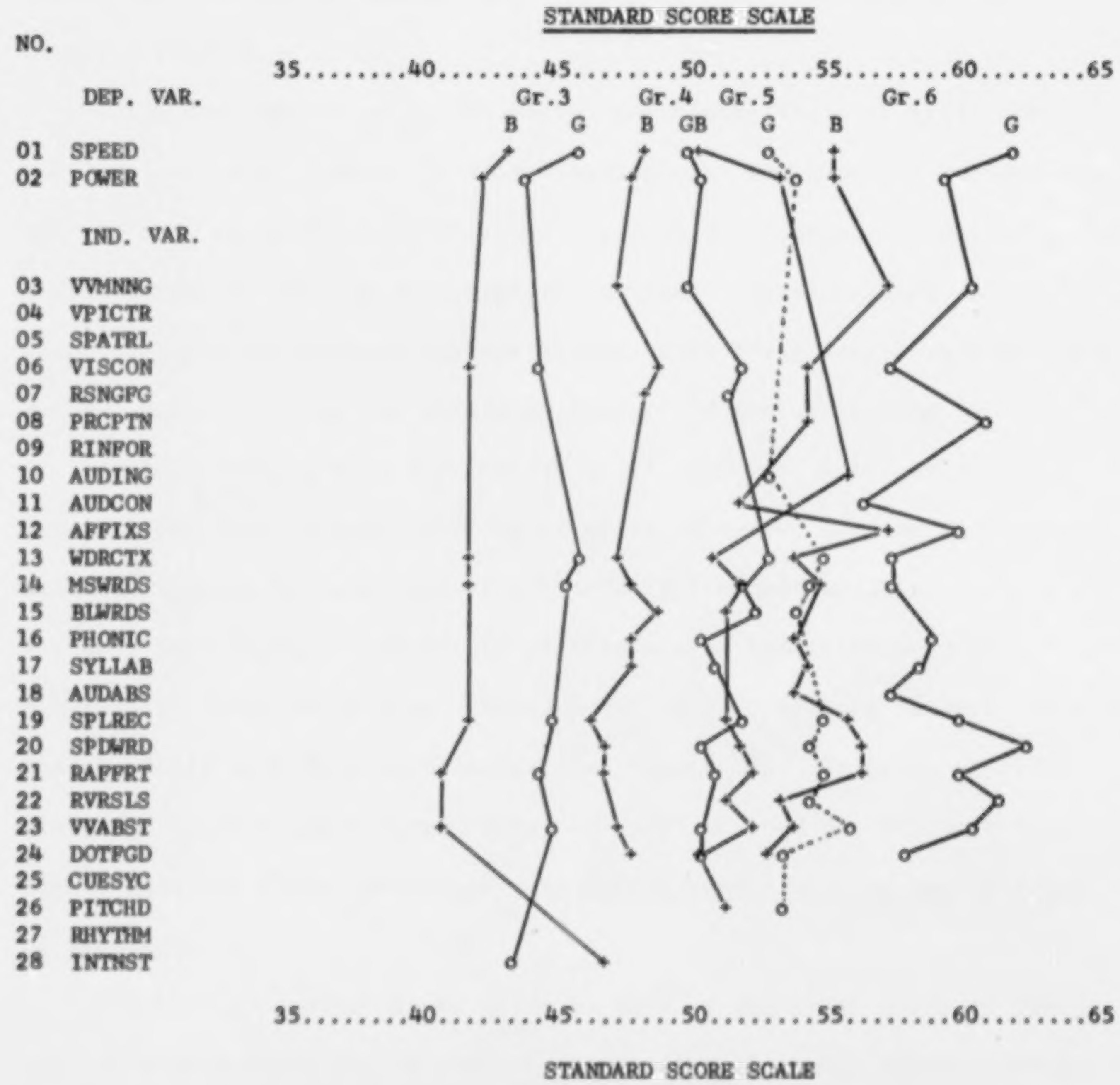

Figure 20. Psychograph of Mean Standard Scores for Boys vs. Girls in Grades 3 through 6. All dependent variables have been plotted, but only independent variables significantly different at the five per cent level are indicated. Lines were drawn between points, however, to guide the eye of the reader. See Table 1 for variable names represented by acronyms in Figure 20.

between girls and boys has increased markedly on Speed and Power of Reading. At this level, girls are significantly better than boys on all visual verbal meaning, word recognition, and most visual perceptual variables. However, on such non-visual verbal tests as Auditory Picture Meaning, Auding, Cue Symbol Closure, Pitch, Rhythm, and Intensity, the groups are not significantly different.

Early development of visual verbal perceptual skill of girls over boys (Balow, 1963) apparently is the springboard for superior achievement in word recognition in the next stage of development, which, in turn, enables girls to develop more rapidly in visual verbal meaning. Consequently, girls in contrast to boys at the third grade have a more adequate general working system for attaining faster and better reading.

As boys develop word recognition skill, however, they could at the fourth grade level almost catch up to girls in Speed, but not in Power of Reading, perhaps because improvement in word recognition ability alone may only be sufficient for better performance on the relatively easy material in Speed of Reading. Development of word meaning in boys could then be built upon this word recognition foundation. In fact, at fifth grade, girls have again surged ahead in Speed of Reading, but boys have almost equalled girls' attainments in *Visual Verbal Meaning and in Power of Reading*.

The marked superiority of girls to boys at the sixth grade in Speed *and* Power of Reading may be due not only to significantly better development in almost all visual verbal meaning and word recognition variables, but also to a more mature organization of these subsystems. This interpretation is consistent with the trend in development of the general working

TABLE 9

MEAN STANDARD SCORES FOR BOYS VS GIRLS IN GRADE 3 THROUGH 6

No.	Name	Grade 3		Grade 4		Grade 5		Grade 6	
Dep.	Var.	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS	BOYS	GIRLS
01	SPEED	43.0	45.5**	48.1	49.5	49.9	52.6*	55.0	61.4**
02	POWER	41.8	43.7*	47.7	50.0*	52.8	53.4	54.8	59.1**
Ind.	Var.								
03	VVMNNG	41.5	42.5	47.2	49.4*	53.5	53.3	57.1	60.0*
04	VPICTR	42.3	41.1	49.2	48.1	54.2	52.2	57.9	59.2
05	SPATRL	45.5	45.4	49.4	48.1	53.2	51.6	54.7	54.6
06	VISCON	41.4	44.4*	48.3	51.3**	51.8	53.7	54.2	57.1*
07	RSNGFG	42.8	45.0	48.1	51.0*	52.1	53.0	54.4	55.8
08	PRCPTN	43.1	43.4	48.8	50.8	50.5	52.4	53.9	60.4**
09	RINFOR	42.6	42.1	48.4	47.5	54.5	52.7	57.4	59.1
10	AUDING	41.3	41.1	49.7	49.3	55.4	52.3**	55.7	57.8
11	AUDCON	43.4	46.0	48.9	50.4	52.2	52.7	51.6	56.2**
12	AFFIXS	42.2	42.4	47.3	49.2	53.2	52.9	57.0	60.2*
13	WDRCTX	41.3	45.7**	47.2	52.6**	50.4	54.5**	53.4	57.2**
14	MSNDWD	41.4	44.8**	47.7	51.6**	51.4	54.0*	54.4	57.2*
15	BLWRDS	43.2	44.4	48.4	52.0**	50.8	53.6*	53.8	55.3
16	PHONIC	43.9	43.1	47.6	50.2*	52.9	52.9	53.4	58.3**
17	SYLLAB	44.0	44.3	47.4	50.7**	51.6	52.7	54.2	57.8*
18	AUDABS	44.0	45.6	48.0	51.3**	51.7	51.5	53.1	56.8**
19	SPLREC	41.3	44.3**	46.0	51.5**	50.8	54.7**	55.6	59.7**
20	SPDWRD	41.8	43.2	46.4	50.1**	51.3	54.1**	55.8	62.1**
21	RAFFRT	40.7	44.2**	46.6	50.7**	52.0	54.3*	55.8	59.6**
22	RVRSLS	43.7	44.5	47.5	49.3	51.0	54.1**	52.8	60.9**
23	VVABST	40.7	44.6**	46.8	50.0**	52.2	55.4**	53.7	60.1**
24	DOTFGD	45.7	46.1	47.5	50.1*	50.1	53.1*	52.6	57.6**
25	CUESYC	45.5	43.8	47.8	48.4	51.4	53.1	55.7	58.4
26	PITCHD	46.1	45.4	49.7	48.1	50.7	53.2*	55.1	54.8
27	RHYTHM	45.2	45.1	47.8	49.3	51.6	52.6	56.0	55.7
28	INTNST	46.4	43.2*	49.6	48.9	53.1	51.6	54.2	54.9

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.

system for the average individual. Thus, differential rate of development in the hierarchical structure of perceptual, word recognition, and word meaning subsystems and their integration and consequent interfacilitation could account for the relative rate of development in Speed and Power of Reading of girls vs. boys in grades 3 through 6.

Whatever may be the causal factor or factors, the earlier "initial kick" (Holmes and Singer, 1961) in the verbal perceptual development of girls over boys gives the girls a superiority that is maintained throughout the elementary grades in their relative rate of development of a hierarchical structure of a general working system for attaining Speed and Power of Reading. Even though girls may receive more favorable reading instruction, particularly in the primary grades (McNeil and Keislar, 1964), boys seem to go through the same sequence of development in their general working system that girls do, although at a lag of about a year.

Although on the average girls are superior to boys in each intermediate grade level in almost all substrata selected variables, it must be emphasized that these differences cannot, of course, be generalized to all boys or all girls in these grades. There is, to be sure, considerable intra-group variability and overlap for boys and girls in general reading ability throughout these grades. Some boys are more powerful and faster readers than most girls; some girls are more powerful and faster than most boys. However, if instruction at each grade level were geared to the average individual, more boys than girls would probably be frustrated because more boys than girls are below the mean. Consequently, instruction would be too advanced for many boys' level of development. Teachers, therefore, are to be cautioned to evaluate level of attainment and subgroup pupils, regardless of sex, according to their specific instructional needs in reading. Under these conditions, each individual is more likely to obtain instruction that is suitable to his or her particular level of development.

Slowest vs. Fastest and Least vs. Most Powerful Readers. To discover the differential rates of development in subabilities and capacities which are related to superior development of Speed or Power of Reading within grades 3 through 6, a comparison was made of the slowest vs. fastest and the least vs. most powerful readers within these grade levels. The mean standard scores of the lower and upper 27.5 per cent of pupils within each grade when arrayed on Speed or Power of Reading were contrasted on each of the variables assessed in this study. Thus, the "slowest" and "fastest" and the "least" and "most powerful" readers are actually the "average" individual in these known-groups.

First, the slowest vs. fastest readers will be compared. The average standard scores of these known-groups, based on a common mean of 50 and standard deviation of 10 for the total sample of 927 pupils, are given in Table 10.[1] A psychograph of their mean standard scores on all variables in this study is shown in Figure 21. Comparison of a more parsimonious set of their mean standard scores, consisting only of first level substrata selected variables for predicting Speed of Reading in grades 3 through 6, is shown in Figure 22.

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[1] Raw score means and standard deviations of the groups contrasted on Speed of Reading are listed in Table P in the Appendix.

TABLE 10

MEAN STANDARD SCORES ON ALL VARIABLES FOR SLOWEST VS. FASTEST READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 3		Grade 4		Grade 5		Grade 6	
Dep. Var.		SLOW	FAST	SLOW	FAST	SLOW	FAST	SLOW	FAST
01	SPEED	35.2	53.9**	39.2	59.4**	40.9	63.2**	43.4	74.5**
02	POWER	39.0	46.9**	43.0	55.1**	45.2	59.9**	46.4	65.6**
IND. VAR.									
03	VVMNNG	37.2	46.9**	41.7	55.7**	45.9	60.8**	48.8	65.6**
04	VPICTR	39.7	44.4**	45.5	53.7**	49.4	58.7**	50.9	66.0**
05	SPATRL	43.9	48.2*	48.4	50.7	51.9	53.8	51.9	57.0*
06	VISCON	36.8	47.4**	43.8	56.0**	46.6	58.0**	46.4	59.8**
07	RSNGFG	41.0	44.3	47.9	52.2**	51.2	54.7*	50.6	58.5**
08	PRCPTN	40.1	45.5**	46.6	53.0**	47.8	55.3**	53.0	61.5**
09	RINFOR	39.9	46.5**	43.7	54.0**	48.1	60.2**	49.8	65.2**
10	AUDING	37.9	44.0**	45.0	55.0**	51.1	58.3**	50.7	62.0**
11	AUDCON	38.6	50.4**	44.4	54.9**	47.2	57.7**	46.0	59.0**
12	AFFIXS	38.8	46.6**	42.7	55.8**	45.7	61.0**	48.4	67.1**
13	WDRCTX	37.7	49.5**	44.2	57.0**	43.9	58.4**	47.3	60.4**
14	MWDSND	37.4	49.5**	41.9	56.5**	44.2	59.2**	47.4	60.7**
15	BLWRDS	40.6	49.0**	44.4	56.8**	44.7	57.8**	46.8	59.6**
16	PHONIC	40.7	47.2**	42.9	55.8**	46.4	59.1**	47.4	62.6**
17	SYLLAB	41.8	48.2**	44.6	55.4**	46.3	57.1**	48.2	61.1**
18	AUDABS	40.6	49.5**	43.9	55.7**	47.3	55.8**	47.0	59.9**
19	SPLREC	36.8	48.8**	42.1	57.1**	44.2	60.0**	48.0	64.8**
20	SPDWRD	37.5	47.2**	42.2	54.6**	46.3	58.2**	50.1	68.4**
21	RAFFRT	37.3	48.3**	44.3	53.9**	48.0	56.6**	52.1	62.3**
22	RVRSLS	43.2	46.5*	45.0	52.8**	48.0	59.2**	49.2	65.9**
23	VVABST	38.7	47.2**	43.8	53.5**	48.0	58.8**	51.1	62.6**
24	DOTFGD	43.9	49.0**	46.5	52.5**	48.7	54.2**	52.5	58.5**
25	CUESYC	44.4	48.0*	45.2	51.2**	49.0	55.2**	53.4	61.2**
26	PITCHD	44.4	48.3**	47.6	52.2**	50.2	54.2**	53.2	58.0*
27	RHYTHM	46.8	43.9	47.0	51.6**	50.2	53.2*	55.1	58.4
28	INTNST	46.6	44.3	47.5	52.7**	50.2	55.0**	51.8	57.3**

*Difference significant at the five per cent level.
**Difference significant at the one per cent level.

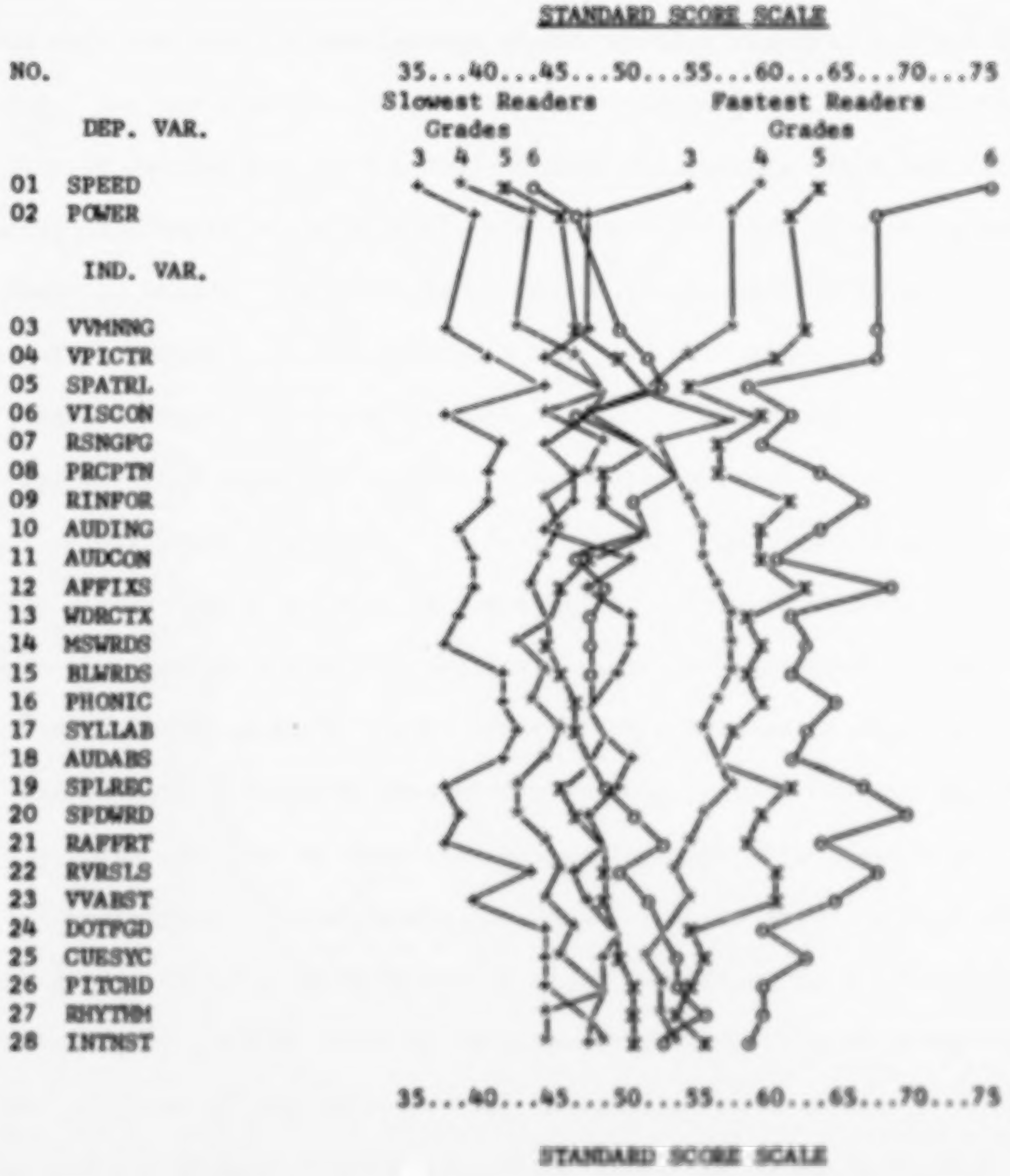

Figure 21. Psychograph of mean standard scores of slowest and fastest readers in grades 3 through 6.

Both psychographs reveal that, in general, the fastest readers at the third grade level are already superior to the slowest readers at the sixth grade level. The rate of increment on the criterion variable, Speed of Reading, for the slowest group in each grade is exceedingly low as compared with the rate of development of the fastest readers in these grades. In fact, for the fastest readers there even seems to be an acceleration in rate of development in Speed of Reading between the fifth and sixth grades! The question is whether this comparative rate of development in Speed of Reading for these known-groups is accompanied by a differential rate of development in the substrata selected variables.

Inspection of Figure 22 reveals that the fastest third graders do not appear to be superior to the slowest sixth graders on substrata selected variables. However, the fastest fourth graders are superior to the slowest sixth graders on almost every substrata selected variable. Moreover, intraindividual variability in substrata selected variables for the fastest sixth graders suggest that their within group superiority is associated with relatively greater development in word meaning variables and in speed and span of word perception, together with control of visual verbal perception. Consequently, at least from the third through the sixth grade, superior development in Speed of Reading is accompanied by quantitatively greater level of development in substrata selected variables. Because of the developmental reorganization that occurs in formation of the general working system for attaining Speed of Reading during the intermediate grades, as shown in Chapter VII, the superior rate of development of the fastest readers from the third grade on could also be attributed to a more mature organization and greater interfacilitation of

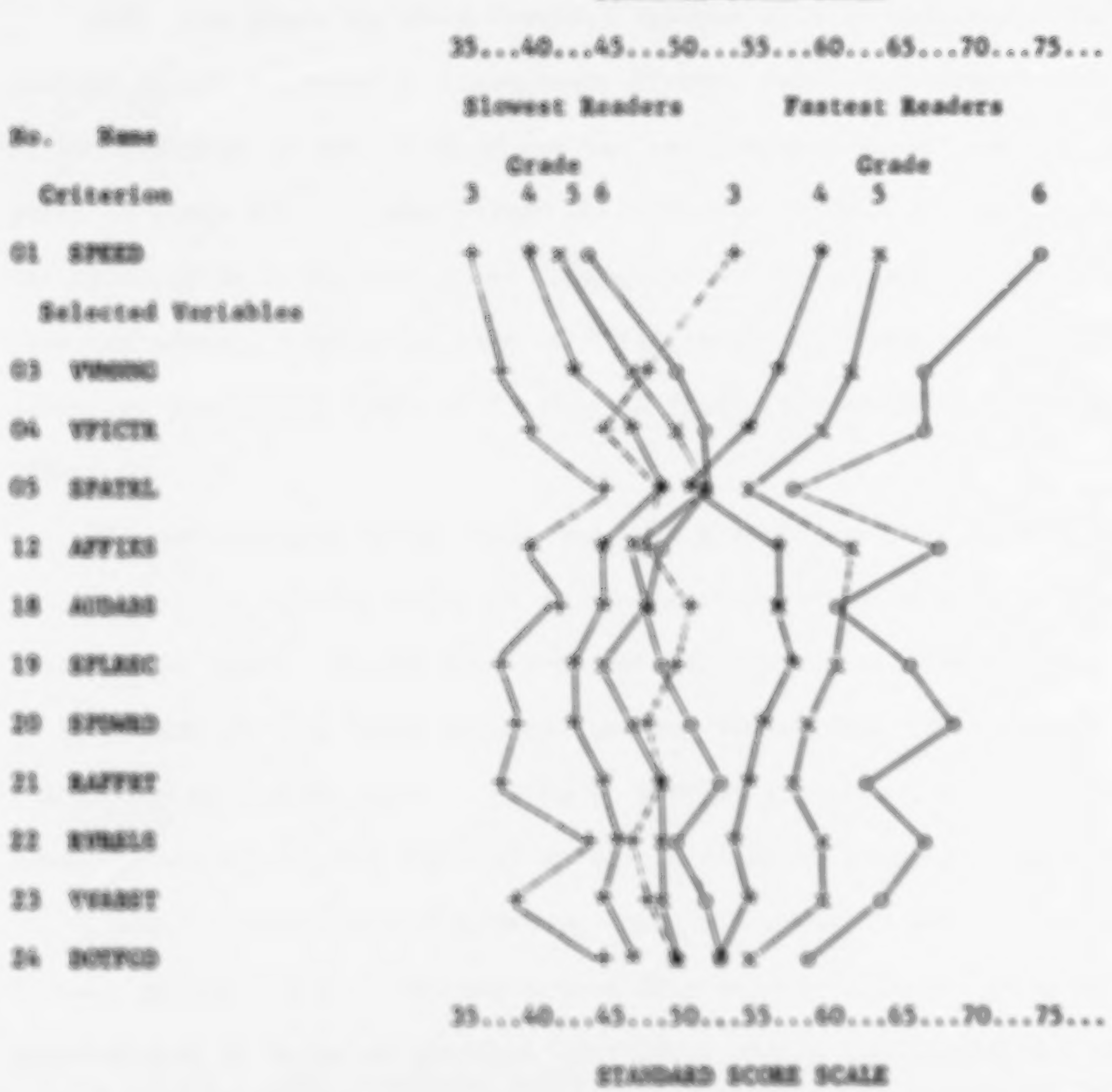

Figure 22. Psychograph of mean standard scores of Level I substrata selected variables for slowest vs fastest readers, grades 3 through 6. The psychograph compares the average standard scores of the upper and lower 27 per cent of pupils in each grade, separated on the criterion variable, Speed of Reading. The standard scores are based on a mean of 50 and a standard deviation of 10, determined from the total sample of 927 pupils in grades 3 through 6. The groups are compared on first level predictors for Speed of Reading at each grade, as shown in Figure 13. These variables, in the order listed in the figure, are: Speed of Reading, Visual Verbal Meaning, Auditory Picture Meaning, Spatial Relations, Meaning of Affixes, Auditory Verbal Abstraction, Spelling Recognition, Speed of Word Perception, Recognition of Affixes and Roots, Word Reversals, Visual Verbal Abstraction, and Dot-Figure Ground Configuration.

subsystems that are mobilized for attaining Speed of Reading.[1]

Next, the Least vs. Most Powerful Readers will be compared. The average standard scores of these known-groups, based on a common mean of 50 and standard deviation of 10 for the total sample of 927 pupils, are given in Table 11.[2] A psychograph of their mean standard scores on all variables in this study is shown in Figure 23. Comparison of their mean standard scores, consisting only of first level substrata selected variables for predicting Power of Reading in grades 3 through 6, is shown in Figure 24.

The psychographs reveal that the most powerful readers at the third grade level are already superior to the least powerful readers at the sixth grade level. On the criterion variable, Power of Reading, the rate of increment for the least powerful is much slower than for the most powerful within each grade level. In fact, between grades 5 and 6, the least powerful readers hardly improved at all in Power of Reading! Certainly the least powerful readers on the average have increased in mental capabilities between grades 5 and 6. To the extent that mental capabilities alone are determinants of Power of Reading, this group should have continued to develop in Power of Reading at the same rate as they had in previous grades. The fact that they did not do so must then be attributed to inadequate

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[1] Of course, there is also some statistical regression towards the mean in relation to the criterion variable which would explain some of the difference between a group's performance in Speed of Reading and its level of development in substrata selected variables.

[2] Raw score means and standard deviations of Least vs. Most Powerful Readers are located in Table Q in the Appendix.

TABLE 11

MEAN STANDARD SCORES ON ALL VARIABLES FOR LEAST VS MOST POWERFUL READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 3		Grade 4		Grade 5		Grade 6	
Dep. Var.		LEAST	MOST	LEAST	MOST	LEAST	MOST	LEAST	MOST
01	SPEED	41.6	48.7**	43.5	56.0**	44.0	58.9**	46.2	70.3**
02	POWER	34.6	52.0**	37.9	59.7**	41.2	65.3**	42.3	68.7**
Ind. Var.									
03	VVMMNG	37.8	49.0**	40.5	56.8**	45.0	62.8**	47.4	66.7**
04	VPICTR	39.6	45.9**	45.2	55.4**	48.2	62.3**	51.4	67.1**
05	SPATRL	39.9	50.6**	45.2	52.9**	50.0	55.8**	50.6	60.2**
06	VISCON	35.3	51.2**	41.4	56.9**	44.6	59.5**	45.8	60.9**
07	RSNGFG	37.6	49.6**	46.2	54.1**	50.3	56.4**	51.2	60.4**
08	PRC/TN	39.5	46.5**	46.5	53.2**	48.4	53.9**	53.4	62.2**
09	RINFOR	38.9	48.4**	42.2	54.1**	47.6	62.5**	50.4	65.6**
10	AUDING	36.3	46.2**	44.2	55.9**	49.4	60.7**	49.8	62.8**
11	AUDCON	36.8	53.7**	42.2	55.3**	44.7	58.9**	44.8	61.1**
12	AFFIXS	40.1	47.4**	41.4	57.0**	44.2	63.1**	47.7	67.6**
13	WDRCTX	35.2	53.5**	40.9	57.7**	42.8	59.0**	45.4	60.4**
14	MWDSND	36.7	52.3**	39.4	57.8**	44.1	60.4**	45.7	61.1**
15	BLWRDS	35.3	52.5**	42.0	57.8**	43.1	58.7**	45.4	60.2**
16	PHONIC	40.3	49.1**	42.0	57.7**	45.3	62.0**	46.1	64.5**
17	SYLLAB	40.5	50.9**	42.8	56.2**	45.2	59.0**	47.4	63.5**
18	AUDABS	37.6	52.9**	42.1	56.6**	45.4	57.6**	47.0	60.6**
19	SPLREC	37.1	50.7**	41.3	56.9**	45.1	59.8**	47.5	64.7**
20	SPDWRD	39.7	46.4**	43.4	53.4**	48.9	56.2**	51.6	65.7**
21	RAFFRT	37.2	48.4**	41.9	53.6**	48.8	57.2**	50.2	62.5**
22	RVRSLS	40.7	48.2**	43.6	53.5**	47.2	58.1**	49.0	65.9**
23	VVARST	37.8	46.0**	44.0	53.0**	49.1	58.1**	51.1	62.3**
24	DOTFGD	46.3	46.3	49.5	51.0	48.9	53.2*	52.7	57.8*
25	CUESYC	43.5	44.7	46.3	50.5**	49.8	54.7**	53.0	62.6*
26	PITCHD	43.2	48.5**	46.1	53.0**	49.3	54.6**	51.9	58.3**
27	RHYTHM	42.7	47.5*	46.2	52.7**	48.6	53.9**	54.4	57.3
28	INTRST	42.8	46.8*	46.6	52.3**	49.8	55.3**	49.8	58.2**

*Difference significant at the five per cent level.
**Difference significant at the one per cent level.

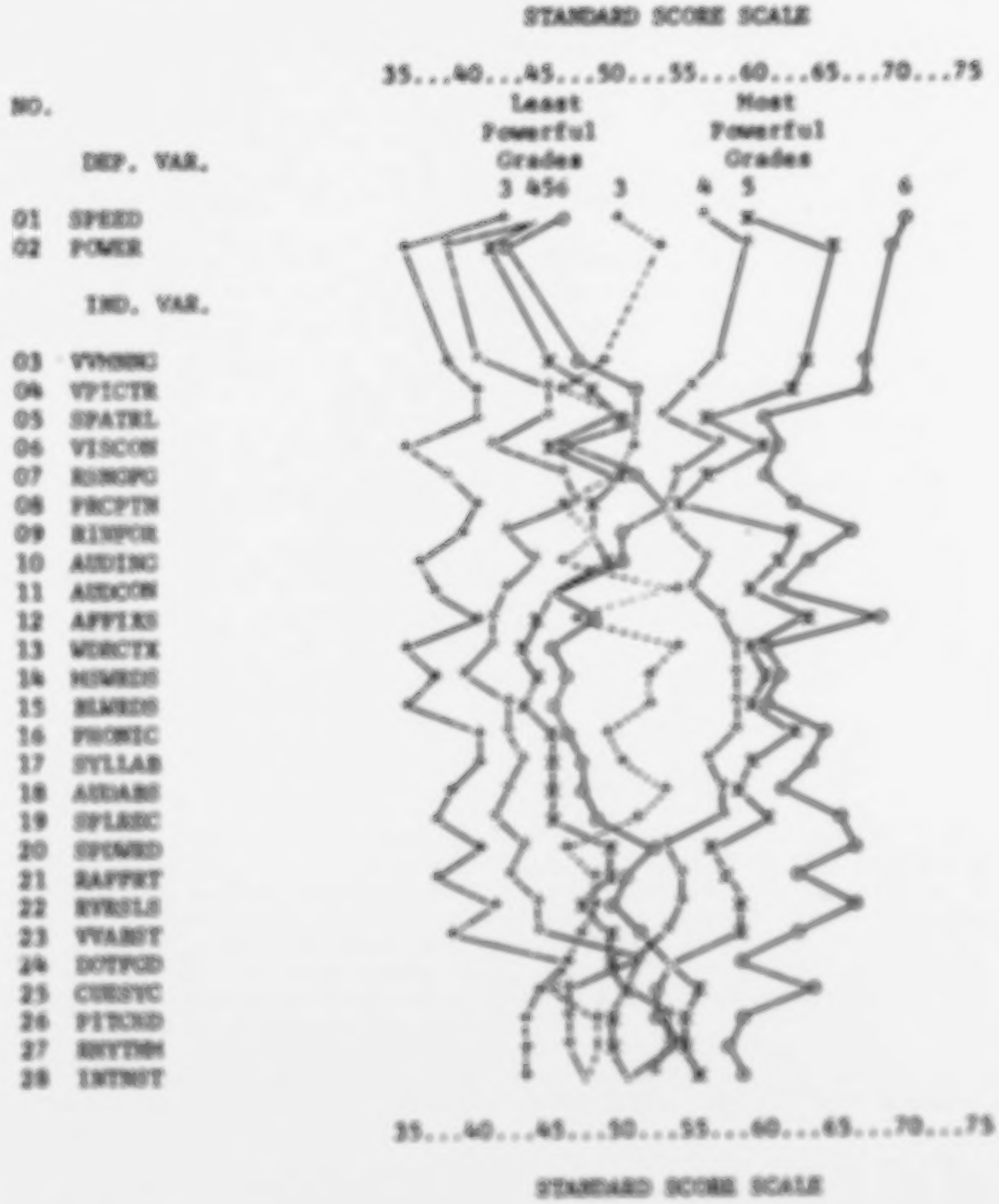

Figure 23. Psychograph of mean standard scores of least vs. most powerful readers in grades 3 through 6.

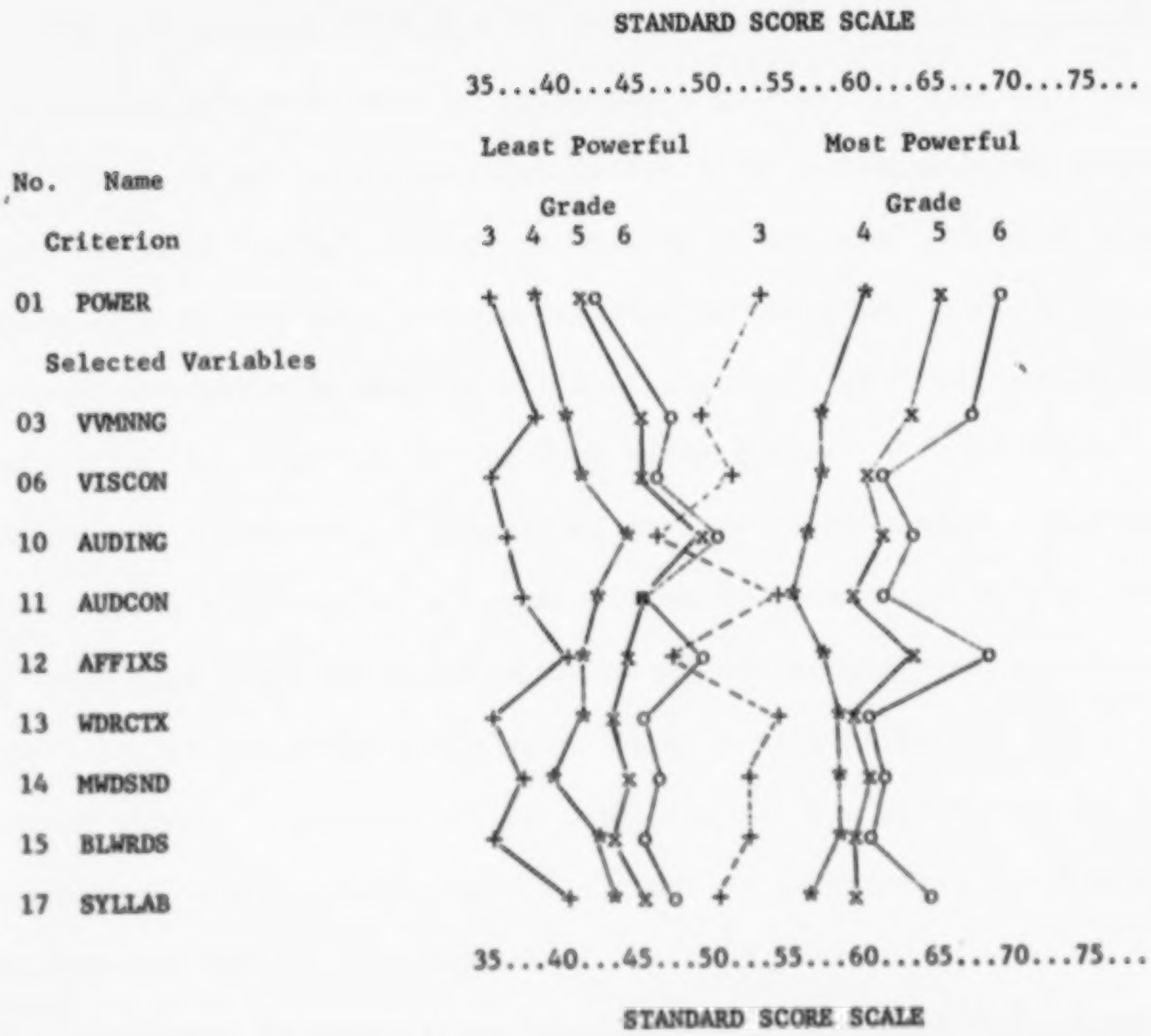

Figure 24. Psychograph of mean standard scores of Level I substrata selected variables for least vs. most powerful, grades 3 through 6. The psychograph compares the average standard scores of the upper and lower 27 per cent of pupils in each grade, separated on the criterion variable, Power of Reading. The standard scores are based on a mean of 50 and a standard deviation of 10, determined from the total sample of 927 pupils in grades 3 through 6. The groups are compared on first level predictors for Power of Reading at each grade, as shown in Figure 15. These variables, in the order listed in the figure, are: Power of Reading, Visual Verbal Meaning, Visual Verbal Conceptualization, Auding, Auditory Verbal Conceptualization, Meaning of Affixes, Word Recognition in Context, Matching Word Sounds, Blending Word Elements, and Syllabication.

learning and perhaps inappropriate instruction for maintaining their rate of development in Power of Reading during the intermediate grades.

The psychograph in Figure 24 reveals the first level substrata variables associated with rate of development in Power of Reading. The most powerful third grader is superior to the least powerful sixth grader in every variable, except Auding and Meaning of Affixes. The within group superiority of the most powerful readers at the sixth grade level, as shown by the peaks in their profile of substrata selected variables appears to lie primarily in the word meaning domain (Visual Verbal Meaning and Meaning of Affixes). Therefore, at least from grades 3 through 6, within grade superiority in Power of Reading is associated with quantitatively more rapid development in almost all substrata selected variables, but at the sixth grade level is more related to the visual verbal meaning domain.[1] Because of the developmental reorganization that occurs in Power of Reading from grades 3 through 6, as reported in Chapter VII, the superior rate of development of the most powerful readers at each grade may also be due to more mature organization and greater interfacilitation among subsystems that are mobilized for attaining Power of Reading.

The differential patterns of development of the slowest vs. fastest and least vs. most powerful readers mean that the more rapidly developing third graders, for example, should not be grouped for instructional purposes with the slower developing sixth graders because (a) the patterns of development of these two groups are not identical and consequently their specific educational needs are different and (b) their rates of learning and potentialities are not identical. The general implication that can be drawn from the psychographs is the necessity for providing these groups with differentiated instruction that is appropriately geared to their present levels of development in each specific substrata selected variable.

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[1] As would be expected, test ceilings on the independent variables were at least approached and in some instances actually reached by some of the superior readers, particularly by some of the fastest and most powerful readers at the sixth grade level. If the tests would have had higher ceilings, then the differences between the fastest vs. slowest and the most vs. least powerful readers on the independent variables would, of course, probably have been even greater.

SUMMARY

To test the hypothesis, which was confirmed, that the relative rate of development in Speed and Power of Reading in grades 3 through 6 is functionally associated with differences between the average individuals of known-groups in magnitude of substrata selected variables, the following groups were contrasted on the criterion measures and substrata selected variables:

(a) *Grade Level*. Improvement in *Speed of Reading* from grade 3 through 6 is associated with development in word meaning, speed and span of whole word recognition, and speed and control of visual verbal perception. Throughout the intermediate grades modality dominance in Speed of Reading is primarily visual. Grade level increments in the intermediate grades in *Power of Reading* are related to development of word meaning, reasoning-in-context, and word recognition subsystems, plus some interfacilitation from central auditory processes. Also, for the average reader at the sixth grade level in Power of Reading, there is an acceleration in the rate of development of Visual Verbal Meaning as compared with Auding, which is consistent with the hypothesis that there is a shift in dominance from the auditory towards the visual modality.

(b) Boys vs. Girls. The average third grade girl is already quantitatively superior to the average third grade boy not only in Speed and Power of Reading but also in certain word recognition and visual verbal conceptualization variables. Although boys tend to catch up to girls in Speed of Reading at the fourth grade and Power of Reading at the fifth grade, the sixth grade boys are markedly below sixth grade girls in both Speed and Power of Reading. At the sixth grade, girls are also superior to boys on all visual verbal meaning, word recognition, and most visual perceptual variables, but the differences between boys and girls are not significant on such non-visual verbal tests as Auding, Cue-Symbol Closure, Pitch, Rhythm, and Intensity. The continued superiority of girls over boys was attributed to a differential rate of development in the hierarchical structure of subsystems that could be mobilized for attaining Speed and Power of Reading.

(c) Fastest vs. Slowest and Least vs. Most Powerful Readers. The fastest third graders, even though not superior in substrata selected variables to the slowest sixth graders, are still more rapid readers than the slowest sixth graders. However, the fastest fourth graders are superior to the slowest sixth graders not only in Speed of Reading, but also in almost every substrata selected variable. Within group superiority in Speed of Reading at the sixth grade is associated with relatively greater development in word meaning variables and in speed and span of word perception together with control of visual verbal perception.

Comparisons within grade groups reveal that in grades 3 through 6 the most powerful are superior to the least powerful group of readers not only in Power of Reading, but also in every substrata selected variable. Indeed, a between grade groups comparison reveals that the most powerful group of readers at the third grade level are superior to the least powerful group of sixth graders in every substrata selected variable, except Auding and Meaning of Affixes. At the sixth grade level, superiority within the group of the most powerful readers lies primarily in the word meaning domain (Visual Verbal Meaning and Meaning of Affixes). Thus, within and between grades superiority in Power of Reading is related to a relatively rapid rate of development in almost every substrata selected variable. But, at the sixth grade level, variation in Power of Reading within the most powerful group of readers appears to be associated primarily with superiority in the visual verbal meaning domain.

Because of the developmental reorganization that occurs in Speed and Power of Reading, as reported in Chapter VII, it can be inferred that the superior rate of development of the fastest and most powerful group of readers at each grade level is associated not only with quantitatively more rapid improvement in substrata selected variables but also with a more mature organization of the general working system.

CHAPTER IX

DEVELOPMENTAL CHANGES IN THE STRUCTURE OF SPEED AND POWER OF READING

The major developmental hypothesis of the substrata-factor theory of reading states that as the average individual learns to read, he gradually develops an hierarchically organized structure of subsystems which can be dynamically mobilized, according to his purposes and the demands of the task, into a general working system for attaining speed and power of reading. In statistical terms, speed and power of reading can be explicated as a linear combination of interrelated components. These components can be identified as loadings upon factors that have been extracted from a correlation matrix of variables selected to assess the various dimensions purported to enter into speed and power of reading. Consequently, factor analysis of matrices constructed from the administration of such variables at grade levels 3 through 6, during which the average individual is improving in speed and power of reading, can test the developmental hypothesis of the substrata-factor theory of reading. If systematic qualitative and/or quantitative changes occur in the pattern of factor loadings of speed and power of reading at the successive grade levels, then the hypothesis would be confirmed.

The minor hypothesis under investigation can also be tested by factor analysis of the correlation matrices at the successive grade levels. The minor hypothesis states that a gradient shift occurs from dominance in auditory to dominance in visual modality as the average individual develops speed and power of reading. If so, then systematic qualitative and/or quantitative changes should occur in the loadings of (a) components of speed and power of reading or (b) components of variables which assess input and mediating abilities and processes that enter into speed and power of reading. If the loadings of these criterion or subcriterion variables systematically shift from auditory towards visual factors, then the minor hypothesis would also be confirmed.

A third hypothesis can also be tested by means of a factor analysis model. As explained elsewhere (Singer, 1965c, pp. 481-482), there is a switch in emphasis from input (word perception and word recognition) to mediational abilities and processing subsystems (word meaning and reasoning-in-context) during the developmental continuum of learning to read:

> ...from an instructional viewpoint, the nature of the reading task changes during the developmental continuum. In the initial stages of reading instruction, development of perceptual and word recognition skills is emphasized. At this stage, individuals have already matured sufficiently in their reasoning or mediational processing systems so that they could adequately comprehend the relatively simple ideas presented in beginning instructional material, provided that their input or word recognition subsystem were adequately developed for transforming stimuli into mental processes. But, during this initial stage there are individual differences in the input system which may be attributable to variation in ability to conceptualize linguistic stimuli (Singer, 1960), effectiveness of instructional strategies, modality sensitivity and receptivity or to an interaction of these sources of variance (Bond, 1935; Fendrick, 1935). However, as individuals progress through the grades, they gradually tend to master word recognition processes (Singer, 1964a); instructional emphasis then shifts to further development of ability to reason about the increasingly complex ideas presented in the instructional material.

The empirical question is whether this shift in instructional emphasis from input to mediational processing systems is reflected in organization for speed and power of reading in grades 3 through 6. The statistical formulation of the hypothesis is that the loadings of word meaning or reasoning-in-context subsystems as compared with the loadings of word recognition and word perception quantitatively increase on those factors upon which speed and/or power of reading correlate as the average individual progresses from grade 3 through grade 6. If so, then this third hypothesis would also be confirmed.

RELATED RESEARCH

Although there have been several studies at the elementary school level in which a factor analysis model had been employed as the statistical tool, none of them investigated developmental changes in the factors which account for variance in speed and power of reading. All of the factor analytic studies on speed and power of reading at the elementary school level that could be culled from the literature are summarized in Table 12. However, only two of the studies most relevant to the present investigation will be reviewed here.

As can be seen in Table 12, only Richardson (1950) used a matrix of variables that is similar to the battery of the present study. Since all of his measures of silent reading were timed, he does not have a test of power of reading in his battery. However, through the use of nonstandardized instruments, he assessed attitudes and experiential background and obtained ratings on such emotional variables as persistence and self-confidence.

A centroid factor analysis of Richardson's matrices, rotated to simple structure, yielded the following three factors which account for approximately 68 and 64 per cent of the common variance for boys and girls, respectively: *General Intelligence*, *Temperament*, and *Mechanics of Reading*. The pattern of factor loadings for the 247 fifth grade boys and girls are very similar, but there are some quantitative differences in the factor

TABLE 12

SUMMARY OF FACTOR ANALYTIC STUDIES OF READING

Elementary school

Investigator, Date, Place; Sex, Grade; Age, Number; Factorial Method	Test Battery	Name of Factors Extracted	Per Cent Common Variance	Rotated Factor Loadings of		
				Power of Reading	Word Meaning	Speed of Reading
[illegible] (1940), U.S., M-F, 4,5, 207. Centroid; Graphic Rotation.	Kuhlmann-Anderson (13-24) Stanford Achievement Battery	Verbal Comprehension	--	57	56	--
		Verbal Fluency	--	61	66	--
		Number (Stanford)	--	26	02	--
		Perc. Speed	--	31	-01	--
		Spatial (KA)	--	-02	16	--
		Communality, h^2		86	75	
Gans (1940), U.S., M-F, 4-5-6, 9-11, 417. Centroid. Oblique Rotation.	Reading Criterion (Composite of Thorndike-McCall and Gates A, B, D) Subtests of Reference Reading	Reading Ability	--	37	--	--
		Selection-Rejection	--	-51	--	--
		Unclear	--	41	--	--
		Delayed Recall	--	-25	--	--
		Unclear	--	-16	--	--
		Communality, h^2		65		
Phelan (1940), U.S., M-F, 4-5, 9-10, 440. Spearman-Moore.	Durrell-Sullivan Reading Achievement Gates Spelling; Perceptual Discrim.; Memory (Meaningful and Nonsense) Cognitive Tests	Cognition	52.31	--	--	--
		Visual Word Perc.	7.36	--	--	--
		Rote Memory for Letters and Words	1.04	--	--	--

TABLE 12--CONTINUED

Sample; Method	Test Battery	Factors	%	P	WM	S
Mandel (1957), U.S., M-F, 4, 106, Centroid, Graphic Rotation, Orthogonal	California Mental Maturity, Iowa Reading Comprehension, " " Vocabulary, Index of Value Orientation Educational Aspirations Reading Materials Index Best Friend	Value Orientation	--	11	21	--
		General Reading Factor	--	78	81	--
		Communality, h^2		62	70	
Kaiser (1953), repeat of Harris (1948a), U.S., M-F 5, 10, 92. "Montana Boys" Centroid; Varimax	Gates A,B,C,D; Pressey Diag. Vocab; Pressey English Test; Dictated Spelling; Written Compositions	Comprehension	28	69	67	--
		Writing Skill	20	18	18	--
		Attention to Acc.	17	34	44	
		Communality, h^2		62	67	
Richardson (1950), England, Males, "Primary School."10, 124. Centroid, Rotated to Simple Structure	Reading Comprehension Tests Verbal and Non-Verbal Intelligence; Auditory and Visual Recall, and Word Discrimination; Spelling; Vocabulary; Assessment of Attitude and Experiential Background; Rating of Persistence and Self Confidence	Gen. Intelligence	54	--	89	89
		Temperament	10	--	07	16
		Mechanics of Reading	5	--	19	02
		Communality, h^2			83	82
Same, except Sample of 123 Girls		Gen. Intelligence	47	--	82	83
		Temperament	12	--	09	33
		Mechanics of Reading	5	--	28	00
		Communality, h^2			76	78
Same, except Sample of 30 of "Most Backward" of the Total Group		Specific Verbal	33	--	75	71
		Non-Verbal Int.	10	--	04	18
		Emotional Factor	13	--	32	37
		Communality, h^2			67	67

loadings for Gates's Silent Reading Test, Form A. As shown in Table 13, Silent Reading correlates .90 for boys and .84 for girls with General Intelligence, a factor which accounts for approximately 50 per cent of the common variance. However, on the Temperament Factor, which accounts for only 10 per cent of common variance, the girls have a loading of .33 and the boys only .17 for Silent Reading. The correlations of -.06 and .00 for boys and girls, respectively, between Silent Reading and Mechanics of Reading are negligible. Although the differences are small, the variation in factor pattern loadings does suggest that the mental organizations in Silent Reading for boys and girls are quantitatively if not qualitatively different.

Table 13

Factor Loadings of Gates Silent Reading, Form A, for
Boys and Girls in Richardson's Study

	Factors		
	General Intelligence	Temperament	Mechanics of Reading
Boys	.90	.17	-.06
Girls	.84	.33	.00

To test the hypothesis that conceptual abilities at the fourth grade level would have significant correlations with the same factors upon which Speed and/or Power of Reading loaded, Singer (1960) administered 36 tests to 60 fourth graders. A varimax rotation of a centroid factor analysis yielded these five factors, which accounted for 93 per cent of the common matrix variance: Visual Verbal Comprehension, Speed of Visual Perception, Auditory Comprehension, Perceptual Discrimination, and Auditory Word Analysis. Speed and Power of Reading, however, did not have significant loadings on Auditory Word Analysis. From these results at the fourth grade level, Singer inferred that Speed and Power of Reading are multidimensional abilities which subsume different amounts of the same centroid factors. Since conceptual abilities did, in fact, have quantitatively similar pattern of loadings upon the same factors that correlated with Speed and Power of Reading, he concluded that the results supported his basic hypothesis.

ANALYSIS OF THE DATA

A principal components factor analysis with communalities of 1.0 was used to factor the correlation matrix at each grade level. The rank of the matrix was specified as the number of eigenvalues equal to or greater than 1.0. Kaiser's (1959) normalized varimax rotation technique for maximum interpretability was employed.[1] Insight into changes in factors from grade to grade was obtained through quantification of the relationships between factors at each grade level.[2]

A paradigm for comparison of the results of the principal components factor analyses for grades 3 through 6 is shown in Figure 25. The figure

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[1] The principal components factor analysis computer program with varimax rotation (FAGD) was written by Dr. Alan B. Wilson, Department of Education and Survey Research Center, University of California, Berkeley.

[2] Dr. Henry Kaiser and Mr. John Bianchini's recently written computer program, "Relating Factors Between Studies Based on Different Individuals," was applied to the varimax rotated factor loadings of this study.

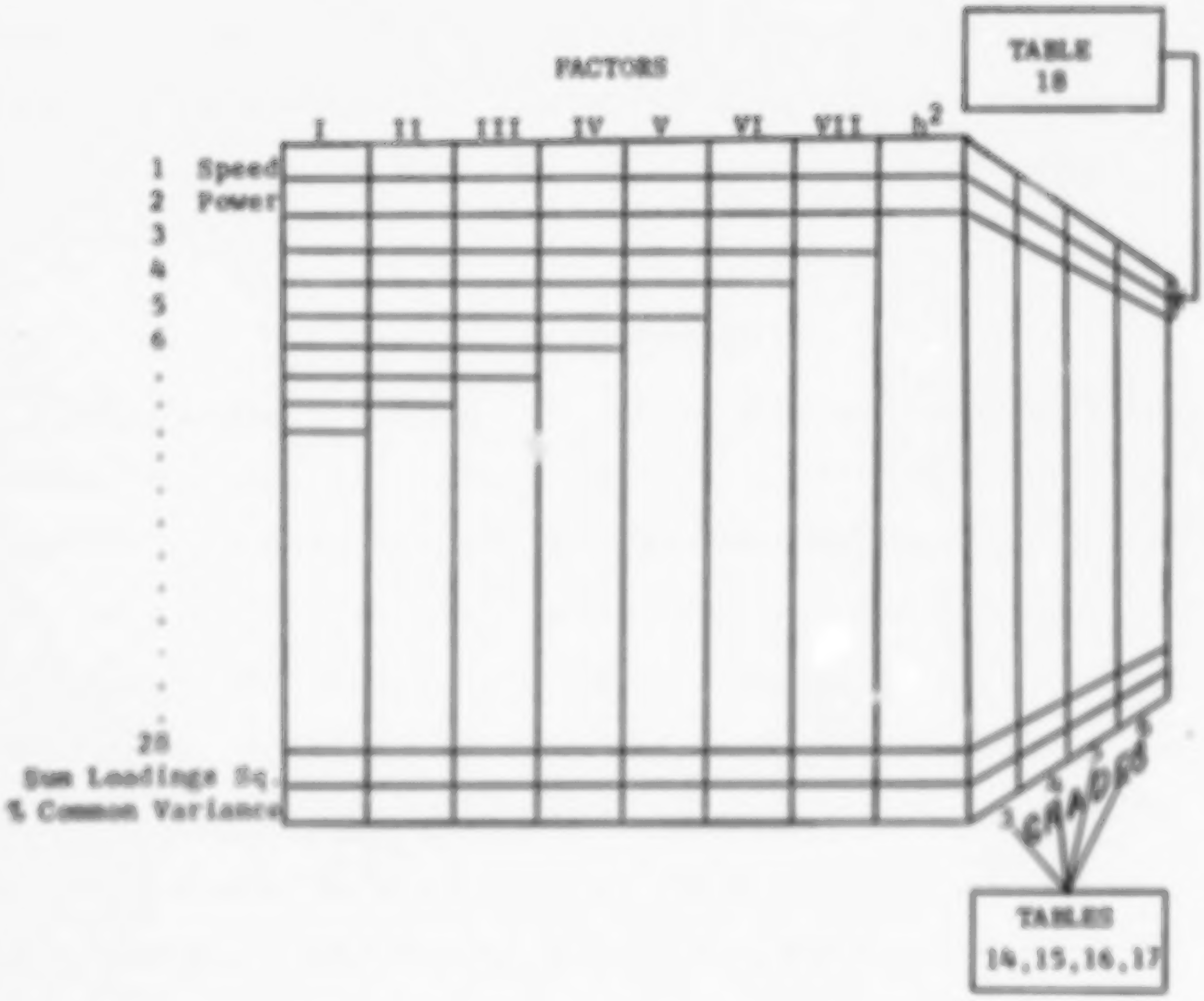
TABLE 18
FACTORS
I
II
III
IV
V
VI
VII
h^2
1 Speed
2 Power
3
4
5
6
28
Sum Loadings Sq.
% Common Variance
3
4
5
6
GRADES
TABLES 14,15,16,17

Figure 25. Paradigm for comparison of results of principal components factor analyses of matrices in grades 3, 4, 5, and 6. The figure indicates that the factor analysis results for each grade are presented in Tables 14, 15, 16, 17. Structural changes for Speed and Power of Reading across grades 3 through 6 are shown in Table 18.

reveals that at each grade level factor loadings, communalities (h^2) for each variable, sum of squared loadings of each variable on each factor, and per cent of common variance accounted for by each factor were computed. The results for grades 3, 4, 5, and 6, represented in the figure by four blocks, are shown in Tables 14, 15, 16, and 17, respectively. Structural changes for Speed and Power of Reading from grade to grade, represented by two horizontal slices across the top of the figure, are presented in Table 18.

RESULTS AND INTERPRETATION

Identification of Factors. The rotated principal component factor loadings for grades 3, 4, 5, and 6 are shown in Tables 14 through 17, respectively. A range of five to six interpretable factors was identified. At the third grade level, Factor I was identified as *Visual Verbal Comprehension* (VVC) because tests with high loadings on this factor assess comprehension, vocabulary, and word recognition abilities. Factor II was labeled as *Visual Relationships* (VR) to represent its saturation of PMA Space, Figure Grouping, and Perception. Factor III was identified as *Auding* (AUD) since the listening tests, such as PMA Pictures, Durrell-Sullivan Reading Capacity, and Range of Information correlate highly with this factor. Factor IV was defined as *Speed of Visual Perception* (SVP) because of significantly large loadings of Speed of Reading, Visual Perception, Speed of Word Perception, Dot-Figure and Ground, and Cue-Symbol Closure. Both Factors V and VI seem to be perceptual factors. Since Rhythm, Intensity, and Auditory Verbal Abstraction have positive correlations while Speed of Reading has a negative correlation with Factor V, it was named *Auditory Perceptual Discrimination* (APD). Factor VI can be

TABLE 14

PRINCIPAL COMPONENTS ROTATED FACTOR LOADINGS

THIRD GRADE

		FACTORS[a]						
No.	Name	1 VVC	2 VR	3 AUD	4 SVP	5 APD	6 AVP	h^2
01	Speed of Reading	.62	-.01	.16	.31	-.33	.09	.62
02	Power of Reading	.73	.27	.31	-.09	.13	.09	.74
03	Visual Verbal Meaning	.78	.07	.35	-.04	.00	.01	.73
04	Auditory Picture Meaning	.23	.04	.79	.09	.12	.16	.72
05	Spatial Relations	.18	.64	.18	.19	.31	.18	.60
06	Visual Verbal Conceptualization	.71	.41	.16	-.04	.07	.02	.71
07	Reasoning with Visual Figures	.24	.73	.01	.08	.32	.00	.65
08	Speed of Visual Perception	.18	.67	.21	.09	-.32	.21	.62
09	Range of Information	.41	.13	.68	.04	.03	.10	.67
10	Auding	.21	.47	.67	.15	.03	.03	.74
11	Auditory Verbal Conceptualization	.67	.38	.19	.02	.02	.11	.64
12	Meaning of Affixes	.61	.09	.33	-.00	-.10	-.13	.52
13	Word Recognition in Context	.82	.24	.10	-.04	.04	.05	.74
14	Matching Word Sounds	.87	.10	.12	-.05	.02	.10	.80
15	Blending Word Elements	.70	.21	.14	-.00	.25	.29	.70
16	Phonics	.65	-.10	.16	.01	.23	.31	.62
17	Syllabication	.59	.09	.13	.10	.09	.38	.54
18	Auditory Verbal Abstraction	.71	.06	.10	-.05	.34	.16	.64
19	Spelling Recognition	.82	.16	.24	.08	-.03	.13	.77
20	Speed of Word Perception	.61	.14	.14	.17	-.27	.32	.61
21	Recognition of Affixes and Roots	.71	.18	-.00	.22	.00	-.09	.59
22	Word Reversals	.34	.38	.05	-.01	.03	.43	.46
23	Visual Verbal Abstraction	.63	.22	-.10	.25	-.05	.20	.56
24	Dot Figure-Ground Configuration	.04	.15	.12	.75	-.02	-.16	.62
25	Cue-Symbol Closure	.03	.09	.04	.79	.07	.15	.66
26	Pitch Discrimination	.10	.13	.14	.03	-.00	.75	.61
27	Rhythm Discrimination	.10	.20	-.03	-.28	.64	.29	.60
28	Tonal Intensity	.04	.09	.14	.13	.79	-.02	.68
	Sum of Squared Loadings	8.54	2.55	2.37	1.64	1.46	1.66	18.07

[a]Identification of Factors	Per Cent Total Variance	Per Cent Communality
1 Visual Verbal Comprehension	30	47
2 Visual Relationships	9	14
3 Auding	8	13
4 Speed of Visual Perception	6	9
5 Auditory Perceptual Discrimination	5	8
6 Auditory Verbal Perception	6	9
Total	64	100

TABLE 15

PRINCIPAL COMPONENTS ROTATED FACTOR LOADINGS

FOURTH GRADE

		FACTORS[a]					
		1	2	3	4	5	
No.	Name	VVC	VR	AUD	SVP	SPD	h^2
01	Speed of Reading	.60	-.18	.41	.36	.15	.72
02	Power of Reading	.75	.13	.41	-.01	.13	.76
03	Visual Verbal Meaning	.75	.01	.41	.01	.15	.76
04	Auditory Picture Meaning	.25	.13	.79	.09	.12	.73
05	Spatial Relations	.14	.74	.19	-.00	.12	.62
06	Visual Verbal Conceptualization	.67	.30	.29	.03	.08	.63
07	Reasoning with Visual Figures	.20	.74	.19	.09	.07	.64
08	Speed of Visual Perception	.27	.57	.03	.40	.07	.56
09	Range of Information	.39	.13	.69	.07	.05	.64
10	Auding	.20	.33	.70	.20	.24	.74
11	Auditory Verbal Conceptualization	.51	.29	.32	.11	.26	.53
12	Meaning of Affixes	.70	.13	.45	.06	.22	.76
13	Word Recognition in Context	.81	.17	.11	-.02	.15	.71
14	Matching Word Sounds	.86	.17	.19	-.00	.03	.80
15	Blending Word Elements	.80	.23	.12	.05	.12	.72
16	Phonics	.74	.17	.26	.02	.16	.67
17	Syllabication	.71	.15	.12	.13	.11	.56
18	Auditory Verbal Abstraction	.75	.19	.15	.00	.08	.63
19	Spelling Recognition	.83	.00	.15	.19	.13	.77
20	Speed of Word Perception	.58	-.02	.10	.47	.15	.59
21	Recognition of Affixes and Roots	.69	.24	.01	.13	.11	.56
22	Word Reversals	.43	.48	.03	.15	.36	.57
23	Visual Verbal Abstraction	.60	.15	.02	.45	.00	.59
24	Dot Figure-Ground Configuration	-.01	.00	.04	.82	-.04	.67
25	Cue-Symbol Closure	.06	.30	.15	.65	.10	.55
26	Pitch Discrimination	.14	.13	.27	-.02	.48	.34
27	Rhythm Discrimination	.19	.16	-.01	.06	.72	.59
28	Tonal Intensity	.08	.01	.13	.02	.74	.58
	Sum of Squared Loadings	8.85	2.44	2.88	1.99	1.88	17.99

[a]Identification of Factors	Per Cent Total Variance	Per Cent Communality
1 Visual Verbal Comprehension	32	49
2 Visual Relationships	9	14
3 Auding	10	16
4 Speed of Visual Perception	7	11
5 Speed of Perceptual Discrimination	7	10
Total	65	100

TABLE 16

PRINCIPAL COMPONENTS ROTATED FACTOR LOADINGS

FIFTH GRADE

		FACTORS[a]					
		1	2	3	4	5	
No	Name	VVC	VR	AUD	SVP	SPD	h^2
01	Speed of Reading	.57	-.23	.41	.38	.10	.71
02	Power of Reading	.66	.04	.57	.08	.04	.76
03	Visual Verbal Meaning	.69	.06	.54	.05	.17	.80
04	Auditory Picture Meaning	.30	.17	.77	.14	.09	.75
05	Spatial Relations	.12	.72	.22	.16	.19	.64
06	Visual Verbal Conceptualization	.68	.25	.31	.07	.20	.66
07	Reasoning with Visual Figures	.26	.71	.16	.08	-.02	.60
08	Speed of Visual Perception	.04	.23	.18	.66	.29	.61
09	Range of Information	.37	.10	.74	.08	.15	.73
10	Auding	.12	.32	.80	.14	.17	.80
11	Auditory Verbal Conceptualization	.60	.21	.32	.19	.02	.54
12	Meaning of Affixes	.64	.04	.58	.14	.14	.78
13	Word Recognition in Context	.76	.09	.27	.13	.11	.70
14	Matching Word Sounds	.86	.02	.24	.12	.09	.82
15	Blending Word Elements	.80	.08	.20	.05	.21	.73
16	Phonics	.77	.22	.25	.02	.17	.73
17	Syllabication	.64	.28	.04	.17	.24	.58
18	Auditory Verbal Abstraction	.72	.27	.05	.03	.15	.62
19	Spelling Recognition	.82	-.02	.25	.14	.08	.77
20	Speed of Word Perception	.46	-.13	.02	.55	.30	.62
21	Recognition of Affixes and Roots	.60	.04	-.02	.20	.11	.42
22	*Word Reversals*	*.42*	*.26*	*.21*	*.45*	*.20*	*.52*
23	Visual Verbal Abstraction	.41	.21	-.03	.55	.12	.53
24	Dot Figure-Ground Configuration	.04	-.07	.10	.78	-.05	.62
25	Cue-Symbol Closure	.07	.13	.09	.69	-.10	.52
26	Pitch Discrimination	.17	.03	.07	.03	.56	.34
27	Rhythm Discrimination	.18	.22	.03	-.01	.71	.59
28	Tonal Intensity	.12	-.05	.26	.16	.57	.42
	Sum of Squared Loadings	7.95	1.82	3.64	2.77	1.76	17.94

[a] Identification of Factors	Per Cent	Per Cent
1 Visual Verbal Comprehension	Total Variance	Communality
2 Visual Relationships	28	44
3 Auding	6	10
4 Speed of Visual Perception	13	20
5 Speed of Perceptual Discrimination	10	16
	6	10
Total	63	100

TABLE 17

PRINCIPAL COMPONENTS ROTATED FACTOR LOADINGS

SIXTH GRADE

No	Name	1-2 AVVC	2-3 AVR	4 SVP	5 SPD	6 AVP	h^2
		FACTORS[a]					
01	Speed of Reading	.72	.22	.32	.14	.08	.70
02	Power of Reading	.81	.29	.13	.04	.07	.77
03	Visual Verbal Meaning	.84	.28	.11	.06	.15	.85
04	Auditory Picture Meaning	.47	.51	.13	.03	.40	.68
05	Spatial Relations	.18	.75	.05	-.07	.19	.63
06	Visual Verbal Conceptualization	.68	.46	.03	.18	-.03	.70
07	Reasoning with Visual Figures	.22	.73	.23	.14	-.03	.66
08	Speed of Visual Perception	.17	.36	.62	.21	-.16	.62
09	Range of Information	.61	.42	.05	.07	.26	.62
10	Auding	.54	.38	.13	.01	.22	.62
11	Auditory Verbal Conceptualization	.58	.48	.14	.08	-.06	.60
12	Meaning of Affixes	.82	.30	.09	.12	.13	.81
13	Word Recognition in Context	.80	.17	.10	.17	-.03	.71
14	Matching Word Sounds	.85	.17	.15	.14	.00	.80
15	Blending Word Elements	.78	.19	.07	.02	.32	.74
16	Phonics	.73	.17	.13	.18	.25	.68
17	Syllabication	.60	.18	.27	.06	.19	.50
18	Auditory Verbal Abstraction	.74	.05	.23	-.03	.20	.66
19	Spelling Recognition	.85	.11	.21	.20	-.09	.82
20	Speed of Word Perception	.36	.15	.39	.63	-.17	.68
21	Recognition of Affixes and Roots	.63	.17	.31	.00	-.02	.53
22	Word Reversals	.53	.30	.40	.25	-.05	.64
23	Visual Verbal Abstraction	.41	.02	.66	.08	-.08	.61
24	Dot Figure-Ground Configuration	.07	.06	.79	-.02	.12	.66
25	Cue-Symbol Closure	.16	.16	.71	-.18	.28	.73
26	Pitch Discrimination	.14	.18	.08	.28	.73	.67
27	Rhythm Discrimination	.06	-.02	-.05	.83	.14	.72
28	Total Intensity	.23	.12	.07	.63	.29	.62
	Sum of Squared Loadings	9.77	3.16	2.86	1.60	1.40	18.85

[a]Identification of Factors		Per Cent Total Variance	Per Cent Communality
1-2	Audio-Visual Verbal Comprehension	35	52
2-3	Auditory Visual Relationships	11	17
4	Speed of Visual Perception	10	15
5	Speed of Perceptual Discrimination	6	8
6	Auditory Verbal Perception	5	8
	Total	67	100

interpreted as Auditory Verbal Perception (AVP) because Pitch, Blending Words, Phonics, and Syllabication have significant loadings on this factor.

The first four factors again appeared in the rotated factor loadings for grades 4 and 5. However, at the fourth and fifth grade only one perceptual factor was extracted. Pitch, Rhythm, Intensity, and Speed of Word Perception have high loadings on this factor. Because speed of perceptual discrimination in auditory and visual modes is common to the variables which correlate with this factor, it was identified as Speed of Perceptual Discrimination (SPD).

A possible explanation for the change from a significant negative correlation between Factor V and Speed of Reading at grade 3 to a slightly positive one at grades 4 through 6 is that in grade 3 there is a shift in instructional emphasis from oral to silent reading that results in some interference in Speed -f Reading. In the primary grades, children are taught oral reading or vocalization of visually perceived stimuli which results in external stimulation of their auditory perceptual system. When instructional stress is shifted to silent reading in grade 3, children consciously inhibit vocalization. The consequent loss of external stimulation to their auditory perceptual system has an inhibitory effect upon Speed of Reading. However, by grade 4, pupils have somewhat acquired the ability to have their auditory and visual domains communicate internally. The net effect of the development of this internal communication system between auditory and visual domains is that there is some intercortical facilitation in processing stimuli and consequent increase in Speed of Reading. This explanation is consistent with the neurological theory of reading formulated by Holmes (1957).

At the sixth grade level, two perceptual factors again emerged. The first can be identified as *Speed of Perceptual Discrimination* because of high loadings of Speed of Word Perception and Rhythm Discrimination. The second is similar to a factor which had precipitated at the third grade level, *Auditory Verbal Perception*, except that Auditory Picture Meaning and Cue-Symbol Closure have higher loadings on this factor at the sixth grade than they had at the third grade.

In grade 6, Factors I, II, IV, and V were again identified. But Factor III, *Auding*, as such, did not emerge. Instead, tests which involve listening, such as Auditory Picture Meaning, Auding, Range of Information, and Auditory Verbal Conceptualization have their two highest loadings at the sixth grade on Factor I, *Visual Verbal Comprehension*, and Factor II, which in previous grades was identified as *Visual Relationships*. Tests that had correlated highly with Factor II in grades 3, 4, and 5, such as PMA Space and Figure-Grouping, at the sixth grade still have their highest loadings on Factor II. Because of the apparent integration of Factors II and III at the sixth grade level, the factor was named *Auding-Visual Relationships* (AVR). The merging of these two factors can be attributed to a greater degree of integration and consequent interfacilitation between visual and auditory mediational subsystems. In like manner, the *Auding* factor of grades 3, 4, and 5 has also become integrated at grade 6 with the *Visual Verbal Comprehension* factor of grades 3, 4, and 5. Therefore, Factor I at grade 6 should be called an *Audio-Visual Verbal Comprehension Factor*.

Factor Loadings of Speed and Power of Reading. Table 10 shows the factor loadings of Speed and Power of Reading on each of the identified

TABLE 18

FACTOR LOADINGS OF SPEED AND POWER OF READING IN GRADES 3 THROUGH 6

		Factor Loadings[a]	[b]						
		1	1-3	3	2-3	2	4	5	6
Criterion	Grade	VVC	AVVC	AUD	AVR	VR	SVP	(A)(S)PD[c]	AVP
Speed of Reading	3	.62	...	.16	...	-.01	.31	-.33	.09
	4	.60	...	.41	...	-.18	.36	.15	...
	5	.57	...	.42	...	-.23	.30	.10	...
	6	→	.72	↔	.22	←	.32	.14	.08
Power of Reading	3	.73	...	.31	...	.27	-.09	.13	.09
	4	.75	...	.41	...	.13	-.01	.13	...
	5	.66	...	.37	...	.04	.08	.04	...
	6	→	.81	↔	.29	←	.13	.04	.07

[a] Identification of Factors

1 Visual Verbal Comprehension
1-3 Audio-Visual Verbal Comprehension
2 Visual Relationships
2-3 Auditory Visual Relationships
3 Auding
4 Speed of Visual Perception
5 (Auditory) (Speed) Perceptual Discrimination
6 Auditory Verbal Perception

[b] Dots indicate that this factor, as such, did not emerge at the particular grade level. Arrows show factor has emerged with another factor as an integrated factor. Thus, at the sixth grade level, Auding has emerged with Visual Verbal Comprehension and Visual Relationships as Audio-Visual Verbal Comprehension and Auditory-Visual Relationships, respectively.

[c] Perceptual Discrimination in grade 3 is Auditory Perceptual Discrimination, but in grades 4 through 6 is Speed of Perceptual Discrimination. The change in this factor is explained in the text.

factors in grades 3 through 6. Speed of Reading at the third grade has a large loading on *Visual Verbal Comprehension*, a negligible loading on *Auding*, a small but significant positive loading on *Speed of Visual Perception*, and a small but significant negative loading on *Auditory Perceptual Discrimination*. In the fourth and fifth grades, Speed of Reading correlates positively with *Visual Verbal Comprehension*, *Auding*, and *Speed of Visual Perception*, but has a small negative loading on *Visual Relationships*. At the sixth grade level, Speed of Reading primarily correlates with *Audio-Visual Verbal Comprehension* and Speed of Visual Perception; its loading with the integrated *Auding* and *Visual Relationships* factor is small, but positive.

Power of Reading at the third grade correlates highly with *Visual Verbal Comprehension*, has a significant loading with *Auding*, but has only a small positive loading on *Visual Relationships*. From the third through the fifth grade, correlation between Power of Reading and *Visual Relationships* steadily decreases but between Power of Reading and *Auding* steadily increases. By the sixth grade, the loading of Power of Reading has substantially increased on *Audio-Visual Verbal Comprehension*, while its loading on the combined *Auding* and *Visual Relationships* factor is small, but positive.

From the developmental trends in Table 18, it is clear that throughout the intermediate grades, Speed and Power of Reading are interrelated, multidimensional abilities. However, qualitatively and quantitatively different organizations of factors enter into the development of Speed and Power of Reading in grades 3 through 6. *Visual Verbal Comprehension* encompasses 44 to 49 per cent of the commonality in grades 3 through 5, but the integrated *Audio-Visual Verbal Comprehension* factor at the sixth grade correlates significantly higher with Speed and Power of Reading and accounts for 53 per cent of the commonality. *Speed of Visual Perception* plays a small, consistent role in Speed of Reading from grades 3 through 6, but hardly enters into Power of Reading at all in these grades. *Auding* accounts for a small, but increasing portion of variance in Speed and Power of Reading in grades 3, 4, and 5. *Visual Relationships* has an increasingly negative relationship with Speed of Reading and a positive but decreasing relationship with Power of Reading in grades 3, 4, and 5. At the sixth grade level, the combined *Auding* and *Visual Relationships* factor has a small but positive correlation with both Speed and Power of Reading. Except for the third grade, perceptual discrimination factors account for only a negligible amount of the variance in Speed and Power of Reading.

The general trend from grades 3 through 6 is towards an increasing integration and dominance of speed of processing and interpreting visual *verbal* stimuli for attaining Speed of Reading and essentially upon visual *verbal* mediational processes for attaining Power of Reading. Non-verbal [illegible]ational processes that lie in the Auding-Visual Relationships domain are only slightly involved in mediating attainment of Speed and Power of Reading. Of course, subsystems at more remote levels could still be mobilised by sixth graders, but degree of attainment in Speed and Power of Reading are primarily attributable to individual differences in the visual verbal domains.

The auditory domains assessed in this study have some degree of relevance for achievement in Speed and Power of Reading at the lower intermediate grades, but by the sixth grade have become increasingly integrated with the visual mediation system. Besides an apparent modality shift at the fifth to sixth grade level, there is possibly a more marked developmental change in which the kinesthetic and auditory modalities shift towards the visual domain in processing and mediating verbal symbols, perhaps at the primary level or even lower. The Auding domain (Factor 3) becomes integrated with Visual Verbal Comprehension (Factor 1) and Visual Relationships (Factor 2) at grade 6 and at this grade then has a facilitory effect on Speed and Power of Reading. Therefore, its contribution at grade 6 is only apparently less than at the previous grades. The integration of the Auding factor into Factors I and II on which Speed and Power of Reading have higher loadings at grade 6 than in the previous grades 3, 4, and 5 surely lends support to the minor hypothesis. Perhaps it would be more appropriate to say that Auding at a more central level of organization augments Speed and Power of Reading as individuals in general progress through the grades.

In general, the factor analyses reveal that nonverbal aspects of intelligence play an increasingly smaller role in the mental organization for attainment of speed and power of reading as the average individual progresses in development of general reading ability during the intermediate grades. Strong (1942) has previously noted that verbal and nonverbal mental tests tap different mental processes.[1] Richardson (1930) also found that reading has only a small loading on the nonverbal intelligence factor for the lower 20 per cent of a group of fifth graders. Gates (1926) concluded that visual perception for words, objects, and geometric symbols are specific abilities. Karwoski, Gramlich, and Arnott (1944) inferred that the longer reaction times for objects and pictures than for words were due to the formulation of an intermediary symbol before a verbal response to objects and pictures could be made. Consistent with these findings is the localization theory of neurology (Nielsen, 1951) with its implications for the reading process (Holmes, 1957) that different areas of the brain are involved in (a) visual perception of objects, pictures, and words and (b) auditory perception of music and language, and that neurological integration of areas for visual perception of printed words and language comprehension is necessary for success in reading. Even at the first grade level, the best predictor of first grade reading achievement was the visual word discrimination subtest of Gates Reading Readiness (Balow, 1963).

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[1] An unresolved theoretical controversy states that nonverbal intelligence tests are limited to estimates of concrete levels of thought while verbal intelligence tests can assess more abstract levels of mental operations. The opposing view is that both types of intelligence tests tap the same mental functions (Singer, 1956). The evidence in this study supports the former side of the controversy (Singer, 1965c).

Although perception of objects, pictures, and auditory stimuli and their association with visual verbal stimuli may be necessary in the initial stages of instruction in order to develop reading ability, it would seem that as individuals, in general, become faster and better readers, Speed and Power of Reading would become more heavily weighted with factors that require perception, retention, manipulation, and conceptualization of written or printed verbal symbols with input through the visual mode. Consequently, an integration among the factors which account for variance in Speed and Power of Reading would be predicted as the average individual improves in these major components of general reading ability. In terms of substrata-factor theory, such an integration would represent the development of a more generalized working system that could be mobilized for attaining speed and power of reading. In fact, the factor analytic results of this study did reveal that at the sixth grade an integration did occur among the factors which account for variance in Speed and Power of Reading. The systematic qualitative and quantitative changes across grades 3 through 6 which were found in the factors and the loadings of Speed and Power of Reading upon these factors mean that the major hypothesis of this study has been confirmed.

Developmental Changes in Major Subsystems of Reading. Two major subsystems of reading are word recognition and word meaning (Singer, 1962). These subsystems can be further subcategorized into visual and auditory abilities and processes. Loadings of these visual and auditory subsystems on the factors which account for their variance can be compared to determine whether there are any systematic changes that accompany development in Speed and Power of Reading.

The loadings of all the word recognition and word meaning variables are consistently high on *Visual Verbal Comprehension*. As this factor becomes more of an integrated *Audio-Visual Verbal Comprehension* factor, it tends to account for an increasingly large portion of the variance in Speed and Power of Reading. When Speed and Power of Reading have their highest loadings on *Audio-Visual Verbal Comprehension* at the sixth grade level, two other variables also have their highest loadings on this factor: Visual Verbal Meaning and Matching Word Sounds. It is interesting to note that both of these variables are first level predictors of Power of Reading at the sixth grade level.

Visual abilities and processes are important in Speed of Reading from grade 3 through grade 6. Auditory word recognition variables, such as Blending Word Elements, Phonics, and Syllabication have small loadings on *Auditory Verbal Perception* which has a *negative* correlation with Speed of Reading at grade 3. On the other hand, these same variables already load high on Factor I at grade 3 as well as in grades 4, 5, and 6. Of course, Factor I is highly saturated with tests of Speed and Power of Reading. Visual word recognition variables, such as Speed of Word Perception, Recognition of Affixes and Roots, Visual Verbal Abstraction, and Word Reversals tend from grades 3 through 6 to increase their loadings on *Speed of Visual Perception*. Furthermore, a significant correlation is maintained by *Speed of Visual Perception* with Speed of Reading from grades 3 through 6. These results on the relationship between factor loadings of visual abilities and Speed of Reading are also consistent with substrata analyses of Speed of Reading in grades 3 through 6.[1]

The analytic evidence, particularly the increases in loadings of Visual Verbal Meaning and Meaning of Affixes on *Visual Verbal Comprehension* at the sixth grade level, is consistent with a shift in instructional emphasis towards word meaning and mediational processing systems as individuals, in general, improve in Speed and Power of Reading. But, it is apparent that the increased facility in *Visual Verbal Comprehension* is achieved by grade 6 through integration of a substantial part of the *Auding* factor into the *Visual Verbal Comprehension* factor. Here one can also infer that the gradient shift is taking place. However, recognition abilities continue to be important throughout the intermediate grades. Visual word recognition processes seem to be necessary for development in Speed of Reading while both visual and auditory or analytic processes are related to improvement in Power of Reading in grades 3 through 6. These findings would suggest that instructional emphasis in word recognition processes should be continued throughout the intermediate grades, but be somewhat differentiated with respect to Speed and Power of Reading. Emphasis upon auditory and analytical word recognition processes would be relevant for development of Power of Reading while stress upon speed of visual or whole word recognition would promote improvement in Speed of Reading. Thus, the instructional shift hypothesis has been supported at the intermediate grade level.

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[1] Anderson (1958) has also demonstrated that high loadings on factors tend to be predictors of the criterion in a Wherry-Doolittle multiple correlation.

SUMMARY

Principal components factor analysis with varimax rotation of correlation matrices in grades 3 through 6 was used to test hypotheses on the development of speed and power of reading. The results revealed the following:

(1) A range of five to six interpretable factors was identified in the four matrices. At the third grade level, Speed of Reading had significant loadings on four factors, one of them a small negative loading. These four factors accounted for 60 per cent of test communality in Speed of Reading. At the sixth grade level, Speed of Reading had increased its loading on *Visual Verbal Comprehension* and maintained a significant loading on *Speed of Visual Perception*, these two factors accounted for 63 per cent

of test communality in Speed of Reading. Thus fewer factors tended to account for more of the variance in Speed of Reading as individuals developed in this component of general reading ability.

Power of Reading correlated significantly with the following three factors, which accounted for 71 per cent of variance in Power of Reading at the third grade level: *Visual Verbal Comprehension*, *Auding*, and *Visual Relationships*. At the sixth grade level, Power of Reading has a much greater loading on *Audio-Visual Verbal Comprehension*, a factor which emerged at this grade level from the integration of *Visual Verbal Comprehension* and *Auding*, than it had on *Visual Verbal Comprehension* or on *Auding* at grades 3, 4, and 5. It is also apparent that the successive decrease of the loadings of Power of Reading on the *Visual Relationships Factor* across grades 3 through 5 is related to the gradual formation of the *Auditory Visual Relationships Factor*, which crystallizes at the sixth grade level. Power of Reading then has a higher loading on *Auditory Visual Relationships* than it had on *Visual Relationships* at the previous grade levels. At the sixth grade level, *Audio-Visual Verbal Comprehension* and *Auditory Visual Relationships* accounted for 75 per cent of the variance in Power of Reading. Thus, with development in Power of Reading, as in Speed of Reading, fewer factors account for more test variance. Thus, qualitatively and quantitatively different organizations of factors enter into the development of Speed and Power of Reading. These developmental trends in factor loadings of Speed and Power of Reading were taken as evidence of the confirmation of the major hypothesis.

(2) The minor hypothesis that a gradient shift from dominance in auditory to dominance in visual modality occurs as the average individual

develops in speed and power of reading was also confirmed. The evidence suggested that from grades 3 through 6, visual perception abilities are dominant in *Speed of Reading*, while both visual and auditory abilities and processes operate in *Power of Reading*. However, at the sixth grade level, the auding domain appears to merge with a realm that involves reasoning about visual or spatial relationships. The combined factors have a facilitory effect on both Speed and Power of Reading. It was inferred that the auding domain enters into speed and power of reading as a more centrally-integrated subsystem as individuals, in general, improve in speed and power of reading. However, the so-called nonverbal aspects of intelligence which load on these factors separately and in combination play an increasingly smaller role in the mental organization for attainment of speed and power of reading as the average individual progresses in development of general reading ability during the intermediate grades.

(3) Factor analytic evidence of this study is consistent with a hypothesis on a shift in instructional emphasis towards word meaning and mediational processing systems as the average individual improves in speed and power of reading. Word meaning variables do increase their loadings on factor I, *Visual Verbal Comprehension*, which in the process of education becomes increasingly integrated with and subsumes and subordinates the *Auding* factor. The integration of *Visual Verbal Comprehension* and *Auding* to form an *Audio-Visual Verbal Comprehension Factor* and the combination and *Visual Relationships* and *Auding* to make an *Auditory Visual Relationships Factor* supports the gradient shift hypothesis of the substrata-factor theory of reading. And these factors account for an increasing amount of variance in Speed and Power of Reading as individuals

progress from grade 3 through 6. Therefore, a shift in emphasis towards word meaning and mediational processes is concomitant with a change in mental organization for speed and power of reading. However, word recognition subsystems also continue to develop during the intermediate grades. An implication for instruction, drawn from the systematic differences that were found between visual and auditory word recognition subsystems in relationship to Speed and Power of Reading was that instructional objectives during grades 3 through 6 might be differentiated with emphasis upon visual word recognition for speed of reading and stress upon auditory and analytical subsystems for power of reading.

CHAPTER X

SUMMARY AND CONCLUSIONS

The purpose of this study was to test the following developmental hypotheses, derived from the substrata-factor theory of reading:

(1) The major developmental hypothesis of the substrata-factor theory of reading states that as an individual learns to read, he sequentially develops an hierarchically organized structure of interrelated neuro-psychological subsystems (Holmes, 1953, 1957, 1960; Singer, 1960; Holmes and Singer, 1961, 1964, 1965). Consequently, improvement in speed and power of reading result not only from changes in the magnitude of substrata-factors which comprise an individual's subsystems, but also from the way in which his subsystems are organized. According to this hypothesis, two individuals could have quantitatively identical subsystems but one individual might still read faster or better than the other because of a superior integration or more mature organization of his subsystems. Thus, for the average reader at each grade level there is a common structure or general working system for attaining speed and power of reading, which undergoes systematic changes as the average individual develops towards maturity in speed and power of reading. Specifically, then, this study sought to determine (a) whether substrata-factors and variables which assess these factors have systematic changes in magnitude and (b) whether the general working system that could be mobilized for attaining speed and power of reading does, in fact, undergo a reorganization in substrata-factors concomitantly with improvement in general reading ability. If the hypothesis was confirmed, then the particular problem was to discover

(a) which of these variables and substrata-factors change and in what degree and (b) which substrata-factors have concomitant changes in organizational position in the general working system as the average individual improves in speed and power of reading.

(2) A minor hypothesis of the substrata-factor theory postulates that as an individual, in general, starts to learn to read, his visual input and mediational processing subsystems must receive stimulation from his kinesthetic and auditory subsystems, if he is to respond with meaning to the printed word (Holmes, 1957). This stimulation communicates kinesthetic and auditory meanings which had previously been acquired from direct contact with objects and from auditory experiences associated with these objects. At first, the individual must depend upon these modalities to give meaning to the stimuli which are taken in and processed in the visual modality. However, as the individual matures in reading, his visual modality becomes less dependent upon his auditory and even less upon his kinesthetic modalities for giving a meaningful response to printed stimuli. Specifically, therefore, the hypothesis is that as an average individual matures in reading ability, his general working system goes through a developmental reorganization in which there is a gradient shift in modality dominance: visual subsystems become increasingly more dominant as compared with auditory subsystems as the average individual integrates them into his general working system for attaining speed and power of reading. That is, substrata-factors that are based upon variables which assess the visual rather than the auditory domain will precipitate in the average individual's general working system hierarchy at a level that is at or closer to his first level predictors of speed

and power of reading as he improves in these components of general reading ability during the upper grades of elementary school. Consequently, one individual could be a faster or better reader than one not only because of superior subabilities or capacities underlying reading, but also because his general working system is organized at a more advanced developmental level in which a more mature process can be mobilized for attaining speed and power of reading.

(3) Comparisons between such known-groups at each grade level as the Average Reader, Boys vs. Girls, Slowest vs. Fastest Reader, and Least vs. Most Powerful Reader were made to determine whether there are intergroup or intragroup differences in rate of development of substrata selected variables.

EXPERIMENTAL DESIGN

The experimental design consisted of (a) the selection of a battery of reliable and valid tests for predicting speed and power of reading, (b) administration of this battery to representative samples of pupils in grades 3 through 6, and (c) statistical tests of the hypotheses by means of substrata analysis, significance of differences between means of known-groups, and principal components factor analysis.

TEST BATTERY

A battery of variables which had precipitated as predictors of speed and power of reading in previous investigations at the college, high school, or elementary school level that were appropriate or could be modified for administration in grades 3 through 6 were selected for testing the two hypotheses formulated for this investigation. The tests and the batteries from which they were selected are as follows:

TEST BATTERY WITH MODIFIED TEST NAMES

A. Gates Reading Survey
    1. Speed of Reading
    2. Power of Reading

B. Thurstone Primary Mental Abilities
    3. Visual Verbal Meaning
    4. Auditory Picture Meaning
    5. Spatial Relations
    6. Visual Verbal Conceptualization
    7. Reasoning with Visual Figures
    8. Perception

C. Van Wagenen-Dvorak Silent Reading
    9. Range of Information

D. Durrell-Sullivan Reading Capacity
    10. Auding

E. Singer Language Perception Tests[1]
    11. Auditory Verbal Conceptualization
    12. Meaning of Affixes
    13. Word Recognition in Context
    14. Matching Word Sounds
    15. Blending Word Elements
    16. Phonics
    17. Syllabication
    18. Auditory Verbal Abstraction
    19. Spelling Recognition
    20. Speed of Word Perception
    21. Recognition of Affixes and Roots
    22. Word Reversals

F. Holmes Language Perception Tests
    23. Visual Verbal Abstraction
    24. Dot Figure-Ground Configuration
    25. Cue-Symbol Closure

G. K-D-H Musical Aptitudes
    26. Pitch Discrimination
    27. Rhythm Discrimination
    28. Tonal Intensity

These tests could also be categorized into these domains: (1) reasoning, (2) listening comprehension, (3) linguistic meaning, (4) auditory word recognition, (5) visual word recognition, (6) visual perception, (7) auditory perception.[2]

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[1] A published version of this battery may be obtained from the Psychological-Educational Services Association, P. O. Box 87, Pebble Beach, California, 1965.

[2] Cluster analysis done at the University of California, Berkeley Computer Center with the BC TRY standard program, in general, statistically confirmed the grouping of variables into these domains.

SAMPLE

All the pupils in grades 3 through 6 in six elementary schools located in an average socio-economic district in Alvord, California constituted the sample of subjects. A total of 927 pupils in these grades took the entire test battery. The grade sample sizes were as follows:

Grade	Sample Size	Boys	Girls
3	223	122	101
4	283	128	155
5	262	140	122
6	159	76	83

The subjects appeared to be representative of the general population of pupils in grades 3 through 6 because the mean scores of the grade level samples on Chronological Age, Primary Mental Abilities I.Q., and Gates Reading Survey (Speed and Level of Comprehension) approximated the standardized test norms. Since many of the subjects had received some instruction in reading in widely scattered schools throughout the United States, the results of this study could not be related to any particular methodological emphasis nor to any one set of materials. Instead, the results must therefore be attributed to a general method of instruction and to a general set of materials.

STATISTICAL PROCEDURES AND RESULTS

The following statistical procedures were employed to test the hypotheses: (1) substrata analysis, (2) analysis by correspondence, and (3) factor analysis. These procedures will be described below, together with their results.

Simple Structure Substrata Analysis

This statistical procedure consists of the utilization and extension of the Wherry-Doolittle Multiple Selection Technique, which is designed to answer the following question: From a correlation matrix what are the fewest variables which will tend to yield a maximal prediction of a criterion? The extension of this Wherry-Doolittle Multiple Selection Technique to the second and third levels of analysis defines the procedure as the Wherry-Doolittle-Holmes substrata analysis. This extension simply eliminates the major criterion from the correlation matrix and substitutes the first level predictors as the subcriteria to be predicted from the remaining variables. The test selection process is then repeated for each subcriterion. Each resulting submatrix is inverted to obtain a multiple regression equation from which the per cent contribution made by each predictor to the variance of the criterion or subcriterion is computed.

In simple structure substrata analysis, however, first level predictors are also eliminated from the matrix as possible predictors of subcriteria at the second and third levels of analysis. Although in the dynamics of mental organization for speed and power of reading, these first level predictors could be utilized by second level subcriteria according to the mutual and reciprocal interaction principle, simple structure substrata analysis is designed to determine the level of predictors in the general organization for speed and power of reading. The basic assumption in this analysis is that the resulting organization will reveal those predictors that are closest to the major criterion and those that are more remote from the major criterion. It is further assumed that when a general working system is mobilized for attaining speed and power of reading, first level predictors will have priority. If the reading problem or task cannot be solved by this working system, then second or third level predictors may be mobilized for solving a subcriterion task. Of course, a particular individual under certain conditions may start off with a working system composed of second or third level predictors and build up to a higher level organization. But, the more effective and efficient working system would be usually composed of the predictors that in the general organization for attaining speed and power of reading are closest to the major criterion. However, the hypothesis that is being tested in this study is that this hierarchical organization is sequentially developed in the reverse from third to first levels. For example, in the initial stages of learning to read, the individual might utilize perceptual discrimination for perceiving parts of words and integrate these discriminations to perceive a whole word. Gradually, this process is subsumed by another level, for example, perceiving the whole word from its configuration alone. Later, the individual could perceive phrases at a glance. In the process of developing this hierarchical organization, the individual reorganizes his general working system to give preferential selection to the more mature subsystems when mobilizing a working system for attaining speed and power of reading. In testing this hypothesis, the results of simple structure substrata analysis were constructed into flow charts to show the organization of a general working system for attaining speed and power of reading at each grade level (Chapters V and VI). The first level predictors of speed and power of reading were then constructed into developmental models (Chapter VII) to show the sequence of development of a hierarchical organization for attaining speed and power of reading. Two examples were given (Chapter VII) of reorganization at the second and third substrata levels in the sequential development of the hierarchy of the general working system that could be mobilized for attaining speed and power of reading.

Results: Substrata analyses of Speed and Power of Reading revealed the following substrata sequences, identified by the first level predictors, in grades 3 through 6:

Criterion: Speed of Reading

Grade	First Level Predictors	Per Cent Contribution to Variance in Speed of Reading
3	Dot Figure-Ground Configuration	3
	Speed and Span of Word Perception	23
	Word Reversals	- 2
	Recognition of Affixes and Roots	9
	Visual Verbal Meaning	14
	Total	47 %
4	Speed and Span of Word Perception	16
	Spatial Relations	- 1
	Spelling Recognition	15
	Meaning of Affixes	19
	Auditory Picture Meaning	8
	Total	57 %
5	Speed and Span of Word Perception	14
	Auditory Verbal Abstraction	- 6
	Visual Verbal Abstraction	6
	Spelling Recognition	16
	Meaning of Affixes	11
	Visual Verbal Meaning	20
	Total	61 %

Criterion: Speed of Reading

Grade	First Level Predictors	Per Cent Contribution to Variance in Speed of Reading
6	Speed and Span of Word Perception	19
	Spelling Recognition	17
	Auditory Picture Meaning	15
	Visual Verbal Meaning	18
	Total	69 %

Criterion: Power of Reading

Grade	First Level Predictors	Per Cent Contribution to Variance in Power of Reading
3	Syllabication	7
	Word Recognition in Context	26
	Auditory Verbal Conceptualization	10
	Auding	7
	Visual Verbal Meaning	16
	Total	66 %
4	Matching Word Sounds	14
	Word Recognition in Context	12
	Visual Verbal Conceptualization	9
	Meaning of Affixes	11
	Auding	6
	Visual Verbal Meaning	19
	Total	71 %
5	Blending Word Elements	9
	Word Recognition in Context	14
	Meaning of Affixes	20
	Auding	8
	Visual Verbal Meaning	18
	Total	69 %
6	Matching Word Sounds	20
	Meaning of Affixes	17
	Visual Verbal Meaning	36
	Total	73 %

Fewer substrata-factors at the sixth grade accounted for more variance in Power of Reading while at the lower grades more substrata-factors accounted for less variance in Power of Reading. These results suggest that during the developmental range from grades 3 through 6 an integration has occurred in the general working system for attaining Power of Reading.

The quantitative and qualitative changes in substrata-factor organization accompanying development in Speed and Power of Reading confirm the major hypothesis of this study.

Trends in the Developmental Model for Speed of Reading: Four developmental trends can be discerned or inferred from the developmental model for Speed of Reading: (1) A gradual change occurs in substrata-factor organization from a predominance of variance attributable to such visual perceptual abilities at the third grade level as Speed of Word Perception, Recognition of Affixes and Roots, and Dot Figure-Ground Configuration to a more equitable distribution of variance among visual perceptual and word meaning factors at the sixth grade level. (2) Although several auditory variables were in the matrix, only factors which were assessed by variables that could be categorized within the visual mode precipitated as positive, first level factors to account for variance in Speed of Reading in grades 3 through 6; even when Auditory Verbal Abstraction, a factor logically classifiable as auditory did emerge in grade 5, it had a negative or suppressor-like effect, perhaps acting to suppress auditory elements so that the working system could then function more efficiently with a perceptual organization composed of factors more visual in their modality. (3) Development of hierarchical organization or sequential integration and subordination of substrata-factors in the general working system was empirically demonstrated from changes in relationships among factors at the second and third substrata levels across grades 3 through 6. For example, Recognition of Affixes and Roots accounts *directly* for some of the variance in Speed of Reading at the third grade level, but only *indirectly* through other factors at higher grade levels. The development of an hierarchical organization in the general working system can be schematically perceived as a cross section through the grades of the developmental model for Speed of Reading. More specifically, Recognition of Affixes and Roots precipitated in the third grade as a first level substrata-factor. At the fourth and fifth grade levels, Recognition of Affixes and Roots contributed through Phonics, as a second level substrata-factor, to variance in Meaning of Affixes, which makes a direct contribution to variance in Speed of Reading. Finally, at the sixth grade level, Meaning of Affixes, as a second level substrata-factor, contributed to variance in Visual Verbal Meaning, which is a first level substrata-factor accounts directly for some of the variance in Speed of Reading. (4) Speed of Word Perception and Verbal Meaning factors precipitated as first level factors at each grade level; consequently, they have to be considered as necessary factors in the developmental working system for attaining Speed of Reading in grades 3 through 6.

Trends in the Developmental Model for Power of Reading: The following trends can be gleaned or inferred from the developmental model for Power of Reading: (1) A combination of context clues and auditory word recognition processes are gradually integrated with other substrata-factors and mobilized throughout the development of the working system for attaining Power of Reading. (2) Both auding and visual verbal meaning systems are mobilized for attaining Power of Reading, but auding at the auditory-visual associational level becomes subordinately integrated with the visual verbal system in the fifth and sixth grades. (3) Individual differences at successively higher grade levels in Power of Reading are less attributable to word recognition processes and more associated with word meaning analysis and knowledge of word meanings and the concepts they represent. (4) Development of a hierarchy or a sequential integration of substrata-factors was empirically demonstrated by changes in relationships among factors at the second and third substrata levels across grades 3 through 6. This hierarchical development can be schematically perceived as a cross section through the grades of the developmental model for Power of Reading. For example, Syllabication accounted directly for some of the variance in Power of Reading at the third grade level. At the fourth grade level it contributed through Visual Verbal Conceptualization to variance in Power of Reading. Finally, at the sixth grade level, Word Recognition in Context contributed through Visual Verbal Meaning to variance in Power of Reading.

Analysis by Correspondence

Comparison of mean standard score differences between known-groups. Because the raw scores of the total group of 927 subjects had been transformed into a common mean and standard deviation, the plotted mean standard scores, called psychographs, could be visually analyzed for *within-group* as well as *between-group* differences on each of the variables at each grade level. Moreover, the average rate of development of these selected variables in relationship to improvement in Speed and Power of Reading from grade to grade could also be discerned in the psychograph.

This analysis was done for the following known-groups at each grade level: Average, Boys vs. Girls, Slowest Readers vs. Fastest Readers, and Least Powerful vs. Most Powerful Readers. The latter two known-groups were defined as the average of the lowest and highest 27 per cent within a grade when arrayed on the criterion, Speed or Power of Reading. The plotted psychographs for these known-groups appear in Chapter VIII. The analyses revealed the following results:

(a) Grade Level. Improvement in Speed of Reading from grade 3 through 6 is associated with development in word meaning, speed and span of whole word recognition, and speed and control of visual verbal perception. Throughout the intermediate grades modality dominance in Speed of Reading is primarily visual. Grade level increments in the intermediate grades in Power of Reading are related to development of word meaning, reasoning-in-context, and word recognition subsystems, plus some interfacilitation from central auditory processes. There was some evidence at the sixth grade level which is consistent with the hypothesis of a shift from auditory to visual modality dominance in Power of Reading during grades 3 through 6.

(b) Boys vs. Girls. The average third grade girl is already quantitatively superior to the average third grade boy not only in Speed and Power of Reading but also in certain word recognition and visual verbal conceptualization variables. Although boys tend to catch up to girls in Speed of Reading at the fourth grade and Power of Reading at the fifth grade, sixth grade boys are markedly below sixth grade girls in both Speed and Power of Reading. At the sixth grade, girls are also superior to boys on all visual verbal meaning, word recognition, and most visual perceptual variables, but the differences between boys and girls are not significant on such nonvisual verbal tests as Auding, Cue-Symbol Closure, Pitch, Rhythm, and Intensity. The continued superiority of girls over boys was attributed to a differential rate of development of the hierarchical structure of subsystems that could be mobilized for attaining Speed and Power of Reading.

(c) _Fastest vs. Slowest and Least vs. Most Powerful Readers_. The fastest third graders are more rapid readers than the slowest sixth graders, but not until the fourth grade is the fastest reader group superior to the slowest sixth graders in almost every substrata selected variable. Continued within-group superiority in Speed of Reading at the sixth grade is associated with relatively greater development in word meaning variables, speed and span of word perception, and control of visual verbal perception.

The most powerful group of readers at the third grade level are superior to the least powerful group of sixth graders not only in Power of Reading but also in almost every variable, except Auding and Meaning of Affixes. In grades 3 through 6, within-grade level superiority in Power of Reading is associated with quantitatively more rapid development in almost all substrata selected variables. Within-group superiority among the most powerful readers at the sixth grade lies primarily in the word meaning domain (Visual Verbal Meaning and Meaning of Affixes).

Because of the developmental reorganization that occurs in Speed and Power of Reading the superior rate of development of the fastest and most powerful group of readers at each grade level is associated not only with quantitatively more rapid improvement in substrata selected variables but also with a more mature organization and consequently greater interfacilitation of subsystems that are mobilized for attaining Speed and Power of Reading.

Factor Analysis

A principal components factor analysis was employed on the correlation matrix at each grade level with varimax rotation of the resulting factors. All factors with eigenvalues greater than 1.0 were extracted from each matrix. Kaiser and Bianchini's program for relating factors on different groups was utilized to determine changes in factors from grade to grade. Factor analysis was thus employed as another approach to testing the hypotheses formulated for this study.

Results: The factor analyses revealed the following: (1) A range of five to six interpretable factors was identified in the four matrices. At the third grade level, Speed of Reading had significant loadings on four factors, one of them a small negative loading. These four factors account for 60 per cent of the communality of Speed of Reading. At the sixth grade level, Speed of Reading had increased its loading on Visual Verbal Comprehension and maintained a significant loading on Speed of Visual Perception. These two factors accounted for 63 per cent of test communality in Speed of Reading. Thus, fewer factors tended to account for more of the variance in Speed of Reading as individuals developed in this component of general reading ability.

At the third grade level, Power of Reading correlated significantly with the following three factors, which accounted for 71 per cent of the variance in Power of Reading: Visual Verbal Comprehension, Auding, and Visual Relationships. At the sixth grade level, Power of Reading had also increased its loading on Visual Verbal Comprehension but still tended to have the same magnitude of correlation with Visual Relationships. These two factors accounted for 75 per cent of the variance in Power of Reading at the sixth grade level. Thus, with development in Power of Reading, fewer factors accounted for more test variance. Moreover, the Auding factor had split and become integrated into the above factors so that there was then evidence at the sixth grade level of Audio-Visual Verbal Comprehension and Auditory Visual Relationships factors. Thus, qualitatively and quantitatively different organizations of factors enter into the development of speed and power of reading. These developmental trends in factor loadings of Speed and Power of Reading were taken as evidence of the confirmation of the major hypothesis.

(2) The minor hypothesis that a gradient shift occurs in the modality for processing and mediating input stimuli from dominance in auditory to dominance in visual modality as the average individual develops in speed and power of reading was also confirmed, but not quite in the way expected. Instead, the evidence suggested that from grades 3 through 6, visual perception abilities are dominant in Speed of Reading, while both visual and auditory abilities and processes operate in Power of Reading. However, at the sixth grade level, the auding domain appears to merge with a realm that involves reasoning about visual or spatial relationships. This combined factor has a facilitory effect on both Speed and Power of Reading. Therefore, it was inferred that the auding domains enters into speed and power of reading as a more centrally-integrated subsystem as individuals, in general, improve in speed and power of reading. However, the so-called nonverbal

aspects of intelligence which load on these factors separately and in combination play an increasingly smaller role in the mental organization for attainment of speed and power of reading as the average individual progresses in development of general reading ability during the intermediate grades.

(3) Factor analytic evidence of this study is consistent with an hypothesis on a shift in instructional emphasis towards word meaning and mediational processing systems as the average individual improves in speed and power of reading. Word meaning variables do increase their loadings on Factor I, Visual Verbal Comprehension which emerges at the sixth grade as the combined Audio-Visual Verbal Comprehension factor. Factor I accounts for an increasing amount of variance in Speed and Power of Reading as individuals progress from grades 3 through 6. Therefore, a shift in emphasis towards word meaning and mediational processes is concomitant with a change in mental organization for speed and power of reading. However, word recognition subsystems continue to develop during the intermediate grades. An implication for instruction, drawn from the systematic differences that were found between visual and auditory word recognition subsystems in relationship to Speed and Power of Reading, was that instructional objectives during grades 3 through 6 might be differentiated with emphasis upon visual word recognition for speed of reading and stress upon auditory and analytical subsystems for power of reading.

CONCLUSIONS

The major developmental hypothesis of the substrata-factor theory was confirmed. A sequential development of a hierarchical organization of substrata-factors does, in fact, accompany improvement in speed and power of reading. Moreover, a reorganization of substrata-factors tends to occur in which first level substrata-factors at lower grade levels become subsumed within substrata-factors at higher grade levels that are or have become more closely associated in the general working system for speed and power of reading. However, certain substrata-factors, such as (a) Visual Verbal Meaning for Speed and Power of Reading and (b) Speed of Word Perception for Speed of Reading are first level factors throughout the intermediate grades. These substrata-factors may, therefore, have developed into this primary position in the organization of the general working system for speed and power of reading during the primary grades.

The minor hypothesis was also confirmed. Throughout the intermediate grades, visual processes are dominant for Speed of Reading, but both visual and auditory processes continue to operate in Power of Reading. However, there was some evidence that auditory abilities and processes may shift along the continuum from more peripheral to more central determinants of Speed and Power of Reading. The evidence seems to support, within the age groups tested, the more sophisticated reformulation of the hypothesis. That is, concomitant with development of general reading ability, auditory and visual subsystems become more closely integrated and function as a more centrally mediated communication system. This integrated subsystem has an interfacilitory effect upon improvement in speed and power of reading.

The shift in instructional emphasis during the intermediate grades towards word meaning and reasoning-in-context abilities and processes was to some degree consistent with their developmental changes in factors that enter into speed and power of reading. Although these mediational subsystems of word meaning and reasoning-in-context become increasingly prominent in the general working system for speed and power of reading, both visual and auditory word recognition subsystems also continue to develop during the intermediate grades. Thus, while some shift in emphasis is warranted, differentiated instruction in word recognition subsystems must also be continued during grades 3 through 6, with stress upon visual word recognition subabilities for Speed of Reading and upon visual and auditory word recognition abilities for Power of Reading.

In general, the average reader develops more or less at an even rate in all of his subabilities and in speed and power of reading throughout the intermediate grades. However, there are some known-group differences. Boys tend to lag behind girls by about one year, alternately catching up with the girls first in speed and then in power of reading. In doing so, the boys develop a general working system that is comparable to the girls. However, at the sixth grade level there is a spurt in the girls' speed and power of reading which suggests a greater degree of interfacilitation in their general working system. This spurt may be related to earlier maturation in girls of a stage of mental development which Piaget (Inhelder and Piaget, 1958; Inhelder, 1963) has defined as the emergence of formal operations and identified as occuurring about age 11 to 12.

During grades 3 through 6, the slowest and least powerful readers are approximately three grades behind the development of the fastest and most powerful readers. Although some of the difference between these known-groups can be attributed to general rate and level of mental development, the inference can be made from the data that the slower and less effective readers are not progressing as rapidly as they should. Consequently, they may also be identified to some degree as "educationally deprived." Perhaps the remedy is better diagnosis and evaluation so that instruction during the intermediate grades can be more effective and efficient.

The results for the known-groups are consistent with the hypothesis that there are at least quantitative differences in the organization of their respective general working systems for attaining speed and power of reading. Because of the confirmation of the major hypothesis of this study, it can also be inferred that there are probably qualitative differences between these known-groups at each grade level in the organization of their general working systems. However, it is also likely that all the known-groups at grade levels 3 through 6 mobilize at least minimum amounts of word meaning and word perception factors in their general working systems. These inferences are consistent with an hypothesis already confirmed at the high school level (Holmes and Singer, 1961).

EDUCATIONAL SIGNIFICANCE

The implications of this study for the classroom teacher are: (a) In general, the working systems at the successive grade levels provide a basis for determining what subskills and what relative degree of emphasis should be placed upon them for the development of speed and power of reading. (b) The developmental models of first level substrata selected variables give curriculum makers an overview of the scope and sequence of factors which make for individual differences in Speed and Power of Reading in grades 3 to 6. These models can, therefore, be used as a cognitive guide for planning and evaluating development of Speed and Power of Reading

(Singer, 1962; Spache, 1964a, 1964b). Because there are some factors common to the developmental working systems for Speed and Power of Reading, instructional emphasis upon these common factors would contribute to the development of both working systems (Singer, 1962). But, individuals also need to mobilize some different subsystems as they shift from Speed to Power of Reading, and vice-versa. These subsystems may be developed most effectively, perhaps, by alternating instruction from accuracy to speed of response, even as early as the initial stages of reading. For example, after an individual has been taught by an analytical method to arrive at an accurate recognition of a word, he can be given practice in a variety of ways for perceiving the word accurately *and* quickly. An individual could, therefore, learn to be *effective* *and* *efficient* in solving his reading tasks. Analogous to the rate, accuracy, and processes necessary for mature development in arithmetic (Brownell, 1961), an individual by alternately developing subsystems necessary for speed and power of reading could consequently make progress towards maturity in both reading components. Thus, the curriculum would emphasize the necessary subsystems in the context of appropriate purposes in order to promote individuals' development of speed and power of reading to their highest potential. The general implication is that instructional emphasis upon the appropriate factors may promote improvement in these major components of general reading ability. Although a broadly organized instructional program is required, it is clear that other factors--to the extent that they are modifiable--should also be included because not all the variance was accounted for at any grade level. These factors may reside in the attitudinal, motivational, verbal flexibility, and biological domains.

(c) Specific developmental instruction can be based upon the substrata-elements that underlie particular subskills; for example, if the teacher wants to develop the subskill of sounding out whole words, not only can the teacher give practice in the subskill per se, but the teacher can also learn from the general working system what elements are drawn upon and organized into this substrata-factor and then provide practice in them in order to facilitate improvement in the subskill of sounding out whole words. (d) Working systems at successive grade levels are cross sections of the general route toward maturity around which individuals may vary. These working systems can then be used as a basis for determining whether the individual is making expected progress. The teacher can plot and then compare the psychographs for the individual with that of his referent group at each grade level. From the deviations, the teacher can judge whether the individual is developing normally, requires some specific developmental instruction, or is beginning to depart from normal development not only in his substrata-elements and the product attained by his mobilized working system, speed and power of reading, but also in his dominant process for achieving general reading ability. Then precise and appropriate educational procedures can be instituted. For example, two individuals may attain the same speed of reading, but one may be minimizing his potential attainment by utilizing an immature process, such as auditory word perception, while the other may have maximized his achievement by calling upon a more mature subskill, such as visual word recognition. For the former pupil, the teacher can then formulate the specific objective of developing and mobilizing into his working system the more mature process. In general, the instructional emphasis during the intermediate grades should shift towards stress on word meaning and reasoning in reading in order to develop a more mature organization of the general working system for attaining speed and power of reading. But, differentiated instruction in word recognition through the intermediate grades should be continued with the objectives of advanced development of analytical and auditory word recognition techniques for Power of Reading, and broader span and more rapid visual word perception for attaining faster Speed of Reading. Of course, individual differences at each grade level must still be met. The implication from comparison of the known-groups is that the slower and the less powerful readers in the intermediate grades are perhaps underprivileged in education at these grade levels because it appears that their rate of development in Speed and Power of Reading has slowed down more than would be expected from their rate of general mental development. The same does not appear to be true of the faster and more powerful readers. Therefore, further instruction, based perhaps on more adequate diagnosis or evaluation, is needed for the slower and less powerful readers. (e) Diagnosis and evaluation of a pupil's reading abilities can be approached parsimoniously through utilization of substrata selected variables. Substrata diagnosis starts with a symptom at the criterion level and proceeds through the relevant levels of the general working system at a particular grade level to discover whether there are causal deficiencies in the underlying variables. For example, if an individual is having difficulty in speed or power of reading, then the first level predictors in the general working system for the given grade level would be administered. If the pupil is deficient in a particular first level variable, then he would take tests which assess the second level predictors of the first level subcriterion, and so on to the third level of diagnosis. For general evaluation, however, all the substrata variables in the general working system for speed and power of reading at a particular grade level would be administered. The pupil's standard scores would then be compared with the mean standard scores of the grade level or whatever referent group would be appropriate. Thus, relative strengths or weaknesses in the pupil's pattern of substrata abilities could be detected. When this evaluation was performed on a 5 1/2 year old precocious reader (Singer, 1965a, p. 295), it was possible to infer from a comparison of her pattern of scores with a reference group of fourth graders that "she could mobilize highly developed auditory and visual word recognition and perceptual skills, along with relatively less developed word meaning and reasoning-in-context abilities, to attain almost a fourth grade level in Speed and Power of Reading." She had an almost mature development of visual and auditory word recognition abilities; however, auditory conceptual ability and listening comprehension were relatively low. Her pattern of abilities was very unevenly developed, which suggested that a combination of precocious development of the corresponding capacities and perhaps some overemphasis in learning and instruction in word recognition areas had occurred. The pattern also implied that if she attempted to read fourth grade level materials, her comprehension would probably exceed her conceptual capability level. In general, the results of the evaluation indicated that this precocious reader needed differentiated instruction at the primary grade level to develop into a well balanced and more skillful reader. (f) The insight gained from the substrata-factor theory of reading and knowledge of the working systems mobilized at successive grade levels will enable the teacher to be versatile in formulating objectives for the class, subgrouping students for the development of particular subskills, and, in general, providing for individual differences in achieving speed and power of reading at increasing levels of maturity.

THEORETICAL SIGNIFICANCE AND RESEARCH IMPLICATIONS

Confirmation of the major and minor hypotheses provides further support for the substrata-factor theory of reading. The evidence adduced to test the minor hypothesis indicated that a more sophisticated statement of the hypothesis could also be supported. And, as such, furnishes additional support for the general premise of the theory which holds that speed and power of reading are separate but interrelated components. In fact, the data of this study indicate that this basic premise is tenable at least as early as the third grade level.

Although invariance of (a) substrata-factors and their per cent contributions to speed and power of reading and (b) factors and loadings of variables on these factors are not to be expected especially when the test batteries (predictor and/or criterion variables) are not identical, the factor analysis at the fourth grade level in this study is markedly in agreement with results obtained with a similar, but not identical, battery of tests on another fourth grade sample (Singer, 1960).

However, results of the substrata analysis of Power of Reading in the 1960 fourth grade sample are more like the present sixth grade sample than they are like the present fourth grade sample. Some of the discrepancy may be attributable to less adequate development of the present sixth grade sample, as suggested by its slightly lower than mean normative score on

Power of Reading and some of the difference may also be attributable to lack of identity in the test batteries. It is also possible that the 1960 sample, which did approximate fourth grade norms in Speed and Power of Reading, had developed a more mature organization of its general working system at an earlier grade level because of a more effective instructional strategy.

Therefore, the hypothesis suggested for future testing is that systematic differences in learning theories and their implicit instructional strategies for teaching reading (Singer, 1965e, 1965f) will, on samples drawn from the same population, result in (a) different rates of development of the organization of the general working system and (b) different kinds of motivation for reading. The more effective instructional strategy would not only develop a more mature organization of a general working system in pupils at an earlier grade level but would also teach the pupils to read to satisfy their own curiosity. Furthermore, this instructional strategy, coupled with a theoretical design for teaching speed and power of reading (Singer 1962, 1965a, 1965g), is likely to result in the development of more rapid and more effective readers.

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APPENDIX

Table A

Correlation Matrix for Grade 3

N=223

[a]	1 SPEED	2 POWER	3 VRBRNG	4 VPICTR	5 SPATRL	6 VISCOM	7 RSNGFG	8 PRCPTN	9 RINFOR	10 AUDING	11 AUDCOM
1. SPEED	1.000	0.438	0.535	0.269	0.185	0.406	0.161	0.269	0.307	0.273	0.434
2. POWER	0.438	1.000	0.685	0.417	0.418	0.660	0.378	0.342	0.540	0.475	0.637
3. VRBRNG	0.535	0.685	1.000	0.451	0.311	0.634	0.258	0.285	0.487	0.379	0.552
4. VPICTR	0.269	0.417	0.451	1.000	0.313	0.329	0.157	0.239	0.517	0.540	0.380
5. SPATRL	0.185	0.418	0.311	0.313	1.000	0.423	0.492	0.421	0.274	0.420	0.355
6. VISCOM	0.406	0.660	0.634	0.329	0.423	1.000	0.453	0.383	0.448	0.433	0.734
7. RSNGFG	0.161	0.378	0.258	0.157	0.492	0.453	1.000	0.379	0.237	0.392	0.452
8. PRCPTN	0.269	0.342	0.285	0.239	0.421	0.383	0.379	1.000	0.288	0.418	0.395
9. RINFOR	0.307	0.540	0.487	0.517	0.274	0.448	0.237	0.288	1.000	0.570	0.438
10. AUDING	0.273	0.475	0.379	0.540	0.420	0.433	0.392	0.418	0.570	1.000	0.430
11. AUDCOM	0.434	0.637	0.552	0.380	0.355	0.734	0.452	0.395	0.438	0.430	1.000
12. AFFIXS	0.454	0.509	0.589	0.306	0.216	0.478	0.222	0.246	0.422	0.320	0.421
13. WDMCTX	0.449	0.727	0.659	0.236	0.341	0.679	0.369	0.321	0.487	0.356	0.607
14. HMWRDS	0.495	0.698	0.690	0.289	0.215	0.658	0.315	0.251	0.491	0.331	0.632
15. BLWRDS	0.332	0.653	0.565	0.321	0.329	0.588	0.316	0.327	0.486	0.384	0.601
16. PHONIC	0.371	0.552	0.562	0.335	0.243	0.481	0.208	0.164	0.361	0.207	0.468
17. SYLLAB	0.387	0.547	0.523	0.337	0.319	0.521	0.250	0.288	0.378	0.254	0.510
18. AUDABS	0.354	0.604	0.613	0.287	0.278	0.562	0.294	0.195	0.381	0.283	0.531
19. SPLREC	0.553	0.688	0.731	0.401	0.313	0.647	0.329	0.340	0.518	0.401	0.667
20. SPLWRD	0.584	0.455	0.509	0.266	0.289	0.459	0.206	0.369	0.391	0.345	0.494
21. RAPFRT	0.476	0.533	0.511	0.254	0.253	0.538	0.256	0.272	0.328	0.249	0.528
22. EVRSLS	0.159	0.396	0.319	0.250	0.367	0.366	0.244	0.372	0.300	0.331	0.357
23. VTABST	0.453	0.498	0.445	0.243	0.289	0.525	0.297	0.254	0.273	0.274	0.466
24. DOTPCD	0.222	0.039	0.040	0.094	0.170	0.066	0.140	0.198	0.159	0.257	0.084
25. CURSVC	0.175	0.033	0.046	0.130	0.252	0.072	0.182	0.136	0.150	0.204	0.123
26. PITCHD	0.176	0.241	0.154	0.193	0.232	0.234	0.238	0.240	0.220	0.164	0.288
27. RHYTHM	-0.026	0.213	0.104	0.097	0.202	0.141	0.205	0.081	0.093	0.132	0.121
28. INTNST	-0.054	0.165	0.087	0.201	0.239	0.150	0.210	0.071	0.123	0.165	0.121

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[a] List of test battery names and acronyms are located in Table 1 on pages 27-28.

Table A (Continued)
Correlation Matrix for Grade 3
N=223

	12 AFFIXS	13 WDRCTX	14 MSWRDS	15 BLWRDS	16 PHONIC	17 SYLLAB	18 AUDABS	19 SPLREC	20 SPDWRD
1. SPEED	0.454	0.449	0.495	0.332	0.371	0.387	0.354	0.553	0.584
2. POWER	0.509	0.727	0.698	0.653	0.552	0.547	0.604	0.688	0.455
3. VVMNNG	0.589	0.659	0.690	0.565	0.562	0.523	0.613	0.731	0.509
4. VPICTR	0.306	0.236	0.289	0.321	0.335	0.337	0.287	0.401	0.266
5. SPATRL	0.216	0.341	0.215	0.329	0.243	0.319	0.278	0.313	0.289
6. VISCON	0.478	0.679	0.658	0.588	0.481	0.521	0.562	0.647	0.459
7. RSNGFG	0.222	0.369	0.315	0.316	0.208	0.250	0.294	0.329	0.206
8. PRCPTN	0.246	0.321	0.251	0.327	0.164	0.288	0.195	0.340	0.369
9. RINFOR	0.422	0.487	0.491	0.486	0.361	0.378	0.381	0.518	0.391
10. AUDING	0.320	0.356	0.331	0.384	0.207	0.254	0.283	0.401	0.345
11. AUDCON	0.421	0.607	0.632	0.601	0.468	0.510	0.531	0.667	0.494
12. AFFIXS	1.000	0.547	0.557	0.391	0.357	0.334	0.422	0.573	0.392
13. WDRCTX	0.547	1.000	0.812	0.675	0.527	0.480	0.589	0.733	0.528
14. MSWRDS	0.557	0.812	1.000	0.669	0.624	0.508	0.595	0.772	0.596
15. BLWRDS	0.391	0.675	0.669	1.000	0.539	0.560	0.653	0.656	0.450
16. PHONIC	0.357	0.527	0.624	0.539	1.000	0.468	0.593	0.562	0.429
17. SYLLAB	0.334	0.480	0.508	0.560	0.468	1.000	0.481	0.564	0.434
18. AUDABS	0.422	0.589	0.595	0.653	0.593	0.481	1.000	0.550	0.393
19. SPLREC	0.573	0.733	0.772	0.656	0.562	0.564	0.550	1.000	0.621
20. SPDWRD	0.392	0.528	0.596	0.450	0.429	0.434	0.393	0.621	1.000
21. RAPFRT	0.401	0.558	0.579	0.535	0.353	0.429	0.436	0.587	0.428
22. RVRSLS	0.244	0.420	0.430	0.537	0.333	0.376	0.316	0.416	0.369
23. VVABST	0.315	0.510	0.530	0.489	0.353	0.472	0.439	0.549	0.496
24. DOTFGD	0.090	0.077	0.053	0.078	0.032	0.048	-0.015	0.152	0.120
25. CUESYC	0.089	0.050	0.039	0.082	0.076	0.118	0.076	0.124	0.153
26. PITCHD	0.117	0.227	0.216	0.322	0.261	0.312	0.184	0.239	0.237
27. RHYTHM	0.073	0.188	0.169	0.245	0.200	0.122	0.269	0.158	0.110
28. INTNST	0.044	0.105	0.105	0.243	0.159	0.159	0.208	0.104	0.009

Table A (Continued)
Correlation Matrix for Grade 3
N=223

	21 RAPFRT	22 RVRSLS	23 VVABST	24 DOTFGD	25 CUESYC	26 PITCHD	27 RHYTHM	28 INTNST
1. SPEED	0.476	0.159	0.453	0.222	0.175	0.174	-0.026	-0.054
2. POWER	0.533	0.396	0.498	0.039	0.033	0.241	0.213	0.165
3. VWMNNG	0.511	0.319	0.445	0.040	0.046	0.154	0.104	0.087
4. VPICTR	0.254	0.250	0.243	0.094	0.130	0.193	0.097	0.201
5. SPATRL	0.253	0.367	0.289	0.170	0.252	0.232	0.202	0.239
6. VISCON	0.538	0.366	0.525	0.066	0.072	0.234	0.141	0.150
7. RSNGFG	0.256	0.244	0.297	0.140	0.182	0.238	0.205	0.210
8. PRCPTN	0.272	0.372	0.254	0.[illegible]98	0.136	0.240	0.081	0.071
9. RINFOR	0.328	0.300	0.273	0.159	0.150	0.220	0.093	0.123
10. AUDING	0.249	0.331	0.274	0.257	0.204	0.164	0.132	0.165
11. AUDCON	0.528	0.357	0.466	0.084	0.123	0.288	0.121	0.121
12. AFFIXS	0.401	0.244	0.315	0.090	0.089	0.117	0.073	0.044
13. WDRCTX	0.558	0.420	0.510	0.077	0.050	0.227	0.188	0.105
14. MSWRDS	0.579	0.430	0.530	0.053	0.039	0.216	0.169	0.105
15. BLWRDS	0.535	0.537	0.489	0.078	0.082	0.322	0.245	0.243
16. PHONIC	0.353	0.333	0.353	0.032	0.076	0.261	0.200	0.159
17. SYLLAB	0.429	0.376	0.472	0.048	0.118	0.312	0.122	0.159
18. AUDABS	0.436	0.316	0.439	-0.015	0.076	0.184	0.269	0.208
19. SPLREC	0.587	0.416	0.549	0.152	0.124	0.239	0.158	0.104
20. SPDWRD	0.428	0.369	0.496	0.120	0.153	0.237	0.110	0.009
21. RAPFRT	1.000	0.355	0.469	0.181	0.149	0.087	0.011	0.119
22. RVRSLS	0.355	1.000	0.407	0.051	0.103	0.209	0.243	0.082
23. VVABST	0.469	0.407	1.000	0.146	0.229	0.134	0.145	0.017
24. DOTFGD	0.181	0.051	0.146	1.000	0.361	0.007	-0.131	0.070
25. CUESYC	0.149	0.103	0.229	0.361	1.000	0.108	-0.072	0.058
26. PITCHD	0.087	0.209	0.134	0.007	0.108	1.000	0.177	0.093
27. RHYTHM	0.011	0.243	0.145	-0.131	-0.072	0.177	1.000	0.219
28. INTNST	0.119	0.082	0.017	0.070	0.058	0.093	0.219	1.000

Table B
Correlation Matrix for Grade 4
N=283

		1 SPEED	2 POWER	3 VVNNNG	4 VPICTR	5 SPATRL	6 VISCON	7 RSNGPG	8 PRCPTN	9 RINFOR	10 AUDING	11 AUDCON
1.	SPEED	1.000	0.608	0.633	0.464	0.097	0.499	0.171	0.283	0.489	0.420	0.417
2.	POWER	0.608	1.000	0.759	0.499	0.304	0.675	0.318	0.306	0.568	0.513	0.585
3.	VVNNNG	0.633	0.759	1.000	0.524	0.233	0.629	0.241	0.288	0.547	0.460	0.524
4.	VPICTR	0.464	0.499	0.524	1.000	0.290	0.420	0.267	0.264	0.552	0.644	0.443
5.	SPATRL	0.097	0.304	0.233	0.290	1.000	0.304	0.468	0.366	0.300	0.371	0.324
6.	VISCON	0.499	0.675	0.629	0.420	0.304	1.000	0.447	0.394	0.476	0.455	0.579
7.	RSNGPG	0.171	0.318	0.241	0.267	0.468	0.447	1.000	0.419	0.329	0.441	0.352
8.	PRCPTN	0.283	0.306	0.288	0.264	0.366	0.394	0.419	1.000	0.187	0.348	0.343
9.	RINFOR	0.489	0.568	0.547	0.552	0.300	0.476	0.329	0.187	1.000	0.577	0.460
10.	AUDING	0.420	0.513	0.460	0.644	0.371	0.455	0.441	0.348	0.577	1.000	0.530
11.	AUDCON	0.417	0.585	0.524	0.443	0.324	0.579	0.352	0.343	0.460	0.530	1.000
12.	AFFIXS	0.641	0.741	0.767	0.566	0.324	0.625	0.368	0.300	0.577	0.517	0.539
13.	WDRCTX	0.522	0.704	0.646	0.318	0.273	0.623	0.310	0.345	0.452	0.352	0.506
14.	MSWRDS	0.558	0.750	0.742	0.370	0.298	0.676	0.326	0.335	0.461	0.382	0.570
15.	BLWRDS	0.516	0.683	0.628	0.360	0.323	0.630	0.348	0.382	0.448	0.359	0.514
16.	PHONIC	0.532	0.632	0.687	0.457	0.316	0.591	0.310	0.313	0.446	0.414	0.504
17.	SYLLAB	0.487	0.592	0.564	0.334	0.235	0.571	0.317	0.306	0.383	0.313	0.452
18.	AUDABS	0.451	0.595	0.643	0.387	0.253	0.566	0.271	0.326	0.390	0.356	0.515
19.	SPLREC	0.637	0.681	0.682	0.385	0.199	0.583	0.287	0.272	0.445	0.369	0.539
20.	SPDWRD	0.582	0.470	0.490	0.276	0.175	0.430	0.188	0.369	0.390	0.336	0.387
21.	RAPFRT	0.406	0.535	0.539	0.300	0.296	0.495	0.339	0.289	0.328	0.324	0.450
22.	RVRSLS	0.332	0.469	0.427	0.278	0.424	0.412	0.426	0.413	0.314	0.393	0.458
23.	VVABST	0.457	0.447	0.431	0.255	0.160	0.474	0.308	0.403	0.374	0.309	0.476
24.	DOTFGD	0.229	0.029	0.032	0.130	0.072	0.045	0.097	0.214	0.058	0.165	0.088
25.	CUESYC	0.270	0.184	0.180	0.187	0.237	0.212	0.268	0.365	0.214	0.316	0.243
26.	PITCHD	0.247	0.261	0.257	0.332	0.170	0.254	0.200	0.211	0.214	0.246	0.277
27.	RHYTHM	0.193	0.259	0.265	0.225	0.235	0.232	0.191	0.199	0.177	0.280	0.339
28.	INTMST	0.209	0.215	0.228	0.146	0.153	0.210	0.177	0.092	0.190	0.324	0.240

Table B (Continued)
Correlation Matrix for Grade 4
N=283

		12 AFFIXS	13 WDRCTX	14 MSWRDS	15 BLWRDS	16 PHONIC	17 SYLLAB	18 AUDABS	19 SPLREC	20 SPDWRD
1.	SPEED	0.641	0.522	0.558	0.516	0.532	0.487	0.451	0.637	0.582
2.	POWER	0.741	0.704	0.750	0.683	0.632	0.592	0.595	0.681	0.470
3.	VVMNNG	0.767	0.646	0.742	0.628	0.687	0.564	0.643	0.682	0.490
4.	VPICTR	0.566	0.318	0.370	0.360	0.457	0.334	0.387	0.385	0.276
5.	SPATRL	0.324	0.273	0.298	0.323	0.316	0.235	0.253	0.199	0.175
6.	VISCON	0.625	0.623	0.676	0.630	0.591	0.571	0.566	0.583	0.430
7.	RSNGFG	0.368	0.310	0.326	0.348	0.310	0.317	0.271	0.287	0.188
8.	PRCPTN	0.300	0.345	0.335	0.382	0.313	0.306	0.326	0.272	0.369
9.	RINFOR	0.577	0.452	0.461	0.448	0.446	0.383	0.390	0.445	0.390
10.	AUDING	0.517	0.352	0.382	0.359	0.414	0.313	0.356	0.369	0.336
11.	AUDCON	0.539	0.506	0.570	0.514	0.504	0.452	0.515	0.539	0.387
12.	AFFIXS	1.000	0.674	0.704	0.631	0.693	0.624	0.601	0.667	0.481
13.	WDRCTX	0.674	1.000	0.757	0.704	0.582	0.556	0.590	0.716	0.500
14.	MSWRDS	0.704	0.757	1.000	0.733	0.711	0.604	0.664	0.752	0.479
15.	BLWRDS	0.631	0.704	0.733	1.000	0.687	0.585	0.702	0.698	0.503
16.	PHONIC	0.693	0.582	0.711	0.687	1.000	0.608	0.724	0.648	0.403
17.	SYLLAB	0.624	0.556	0.604	0.585	0.608	1.000	0.564	0.628	0.446
18.	AUDABS	0.601	0.590	0.664	0.702	0.724	0.564	1.000	0.607	0.383
19.	SPLREC	0.667	0.716	0.752	0.698	0.648	0.628	0.607	1.000	0.583
20.	SPDWRD	0.481	0.500	0.479	0.503	0.403	0.446	0.383	0.583	1.000
21.	RAFFRT	0.540	0.541	0.577	0.568	0.598	0.529	0.594	0.589	0.448
22.	RVRSLS	0.487	0.518	0.473	0.463	0.399	0.390	0.418	0.423	0.423
23.	VVABST	0.423	0.445	0.508	0.501	0.460	0.477	0.431	0.591	0.536
24.	DOTFGD	0.091	0.014	0.043	0.071	0.069	0.067	0.055	0.161	0.253
25.	CUESYC	0.234	0.111	0.157	0.203	0.236	0.273	0.203	0.191	0.231
26.	PITCHD	0.308	0.207	0.213	0.267	0.358	0.231	0.239	0.200	0.166
27.	RHYTHM	0.331	0.285	0.203	0.264	0.298	0.230	0.228	0.282	0.183
28.	INTNST	0.252	0.184	0.142	0.187	0.169	0.173	0.150	0.187	0.185

Table B (Continued)
Correlation Matrix for Grade 4
N=283

		21 RAFFRT	22 RVRSLS	23 VVABST	24 DOTFGD	25 CUESYC	26 PITCHD	27 RHYTHM	28 INTNST
1.	SPEED	0.406	0.332	0.457	0.229	0.270	0.247	0.193	0.209
2.	POWER	0.535	0.469	0.447	0.029	0.184	0.261	0.259	0.215
3.	VVMNNG	0.539	0.427	0.431	0.032	0.180	0.257	0.265	0.228
4.	VPICTR	0.300	0.278	0.255	0.130	0.187	0.332	0.225	0.146
5.	SPATRL	0.296	0.424	0.160	0.072	0.237	0.170	0.235	0.153
6.	VISCON	0.495	0.412	0.474	0.045	0.212	0.254	0.232	0.210
7.	RSNGFG	0.339	0.426	0.308	0.097	0.268	0.200	0.191	0.177
8.	PRCPTN	0.289	0.413	0.403	0.214	0.365	0.211	0.199	0.092
9.	RINFOR	0.328	0.314	0.374	0.058	0.214	0.214	0.177	0.190
10.	AUDING	0.324	0.393	0.309	0.165	0.316	0.246	0.280	0.324
11.	AUDCON	0.450	0.458	0.476	0.088	0.243	0.277	0.339	0.240
12.	AFFIXS	0.540	0.487	0.423	0.091	0.234	0.308	0.331	0.252
13.	WDRCTX	0.541	0.518	0.445	0.014	0.111	0.207	0.285	0.184
14.	MSWRDS	0.577	0.473	0.508	0.043	0.157	0.213	0.203	0.142
15.	BLWRDS	0.568	0.463	0.501	0.071	0.203	0.267	0.264	0.187
16.	PHONIC	0.598	0.399	0.460	0.069	0.236	0.358	0.298	0.169
17.	SYLLAB	0.529	0.390	0.477	0.067	0.273	0.231	0.230	0.173
18.	AUDABS	0.594	0.418	0.431	0.055	0.203	0.239	0.228	0.150
19.	SPLREC	0.589	0.423	0.591	0.161	0.191	0.200	0.282	0.187
20.	SPDWRD	0.448	0.423	0.536	0.253	0.231	0.166	0.183	0.185
21.	RAFFRT	1.000	0.411	0.522	0.102	0.218	0.172	0.271	0.144
22.	RVRSLS	0.411	1.000	0.363	0.098	0.275	0.262	0.358	0.232
23.	VVABST	0.522	0.363	1.000	0.248	0.269	0.104	0.182	0.113
24.	DOTFGD	0.102	0.098	0.248	1.000	0.404	0.007	0.075	0.025
25.	CUESYC	0.218	0.275	0.269	0.404	1.000	0.150	0.132	0.128
26.	PITCHD	0.172	0.262	0.104	0.007	0.150	1.000	0.236	0.201
27.	RHYTHM	0.271	0.358	0.182	0.075	0.132	0.236	1.000	0.292
28.	INTNST	0.144	0.232	0.113	0.025	0.128	0.201	0.292	1.000

Table C
Correlation Matrix for Grade 5
N=262

		1 SPEED	2 POWER	3 VVMNNG	4 VPICTR	5 SPATRL	6 VISCON	7 RSNGFG	8 PRCPTN	9 RINFOR	10 AUDING	11 AUDCON
1.	SPEED	1.000	0.617	0.643	0.474	0.134	0.498	0.154	0.318	0.524	0.381	0.457
2.	POWER	0.617	1.000	0.748	0.616	0.270	0.641	0.273	0.206	0.608	0.541	0.597
3.	VVMNNG	0.643	0.748	1.000	0.694	0.292	0.668	0.304	0.241	0.664	0.505	0.597
4.	VPICTR	0.474	0.616	0.694	1.000	0.369	0.467	0.296	0.305	0.680	0.701	0.464
5.	SPATRL	0.134	0.270	0.292	0.369	1.000	0.322	0.403	0.284	0.300	0.434	0.275
6.	VISCON	0.498	0.641	0.668	0.467	0.322	1.000	0.442	0.306	0.558	0.427	0.583
7.	RSNGFG	0.154	0.273	0.304	0.296	0.403	0.442	1.000	0.260	0.268	0.368	0.336
8.	PRCPTN	0.318	0.206	0.241	0.305	0.284	0.306	0.260	1.000	0.251	0.307	0.272
9.	RINFOR	0.524	0.608	0.664	0.680	0.300	0.558	0.268	0.251	1.000	0.663	0.486
10.	AUDING	0.381	0.541	0.505	0.701	0.434	0.427	0.368	0.307	0.663	1.000	0.424
11.	AUDCON	0.457	0.597	0.597	0.464	0.275	0.583	0.336	0.272	0.486	0.424	1.000
12.	AFFIXS	0.635	0.763	0.764	0.619	0.286	0.668	0.297	0.286	0.647	0.561	0.579
13.	WDRCTX	0.572	0.699	0.669	0.433	0.261	0.674	0.337	0.248	0.500	0.354	0.574
14.	MSWRDS	0.612	0.707	0.743	0.473	0.217	0.665	0.291	0.220	0.515	0.336	0.572
15.	BLWRDS	0.529	0.662	0.667	0.427	0.246	0.665	0.274	0.195	0.464	0.369	0.548
16.	PHONIC	0.503	0.645	0.696	0.508	0.320	0.612	0.363	0.174	0.506	0.397	0.535
17.	SYLLAB	0.397	0.461	0.542	0.390	0.342	0.505	0.304	0.228	0.395	0.266	0.432
18.	AUDABS	0.359	0.505	0.609	0.333	0.292	0.531	0.277	0.167	0.407	0.281	0.520
19.	SPLREC	0.665	0.653	0.708	0.457	0.229	0.635	0.295	0.214	0.499	0.322	0.557
20.	SPDWRD	0.559	0.340	0.363	0.274	0.170	0.400	0.171	0.408	0.276	0.179	0.404
21.	RAFFRT	0.378	0.372	0.441	0.318	0.211	0.448	0.192	0.187	0.277	0.182	0.366
22.	RVRSLS	0.477	0.445	0.431	0.373	0.375	0.444	0.328	0.421	0.405	0.380	0.409
23.	VVABST	0.429	0.345	0.325	0.230	0.277	0.397	0.218	0.421	0.262	0.234	0.417
24.	DOTFGD	0.275	0.149	0.132	0.188	0.086	0.075	0.055	0.405	0.136	0.174	0.162
25.	CUESYC	0.246	0.169	0.153	0.194	0.199	0.109	0.119	0.338	0.136	0.187	0.204
26.	PITCHD	0.160	0.167	0.264	0.192	0.170	0.249	0.094	0.124	0.184	0.209	0.161
27.	RHYTHM	0.163	0.213	0.319	0.177	0.254	0.320	0.163	0.260	0.217	0.211	0.216
28.	INTNST	0.240	0.261	0.267	0.224	0.159	0.256	0.138	0.209	0.273	0.282	0.186

Table C (Continued)
Correlation Matrix for Grade 5
N=262

		12 AFFIXS	13 WDRCTX	14 MSWRDS	15 BLWRDS	16 PHONIC	17 SYLLAB	18 AUDABS	19 SPLREC	20 SPDWRD
1.	SPEED	0.635	0.572	0.612	0.529	0.503	0.397	0.359	0.665	0.559
2.	POWER	0.763	0.699	0.707	0.662	0.645	0.461	0.505	0.653	0.340
3.	VVMNNG	0.764	0.669	0.743	0.667	0.696	0.542	0.609	0.708	0.363
4.	VPICTR	0.619	0.433	0.473	0.427	0.508	0.390	0.333	0.457	0.274
5.	SPATRL	0.286	0.261	0.217	0.246	0.320	0.342	0.292	0.229	0.170
6.	VISCON	0.668	0.674	0.665	0.665	0.612	0.505	0.531	0.635	0.400
7.	RSNGFG	0.297	0.337	0.291	0.274	0.363	0.304	0.277	0.295	0.171
8.	PRCPTN	0.286	0.248	0.220	0.195	0.174	0.228	0.167	0.214	0.408
9.	RINFOR	0.647	0.500	0.515	0.464	0.506	0.395	0.407	0.499	0.276
10.	AUDING	0.561	0.354	0.336	0.369	0.397	0.266	0.281	0.322	0.179
11.	AUDCON	0.579	0.574	0.572	0.548	0.535	0.432	0.520	0.557	0.404
12.	AFFIXS	1.000	0.698	0.694	0.631	0.662	0.501	0.517	0.715	0.397
13.	WDRCTX	0.698	1.000	0.779	0.676	0.598	0.520	0.511	0.752	0.436
14.	MSWRDS	0.694	0.779	1.000	0.746	0.753	0.580	0.650	0.780	0.462
15.	BLWRDS	0.631	0.676	0.746	1.000	0.714	0.567	0.642	0.712	0.411
16.	PHONIC	0.662	0.598	0.753	0.714	1.000	0.664	0.706	0.676	0.349
17.	SYLLAB	0.501	0.520	0.580	0.567	0.664	1.000	0.544	0.553	0.420
18.	AUDABS	0.517	0.511	0.650	0.642	0.706	0.544	1.000	0.546	0.285
19.	SPLREC	0.715	0.752	0.780	0.712	0.676	0.553	0.546	1.000	0.501
20.	SPDWRD	0.397	0.436	0.462	0.411	0.349	0.420	0.285	0.501	1.000
21.	RAFFRT	0.383	0.403	0.513	0.456	0.456	0.398	0.445	0.515	0.447
22.	RVRSLS	0.505	0.512	0.473	0.417	0.472	0.533	0.370	0.504	0.441
23.	VVABST	0.314	0.422	0.389	0.405	0.372	0.398	0.378	0.377	0.419
24.	DOTFGD	0.187	0.103	0.175	0.148	0.123	0.126	0.117	0.161	0.350
25.	CUESYC	0.196	0.189	0.178	0.110	0.134	0.228	0.177	0.183	0.254
26.	PITCHD	0.197	0.218	0.221	0.287	0.216	0.222	0.244	0.204	0.239
27.	RHYTHM	0.255	0.279	0.229	0.310	0.289	0.305	0.293	0.200	0.191
28.	INTNST	0.322	0.232	0.250	0.244	0.320	0.249	0.189	0.255	0.270

Table C (Continued)
Correlation Matrix for Grade 5
N=262

		21 RAFFRT	22 RVRSLS	23 VVABST	24 DOTFGD	25 CUESYC	26 PITCHD	27 RHYTHM	28 INTNST
1.	SPEED	0.378	0.477	0.429	0.275	0.246	0.160	0.163	0.240
2.	POWER	0.372	0.445	0.345	0.149	0.169	0.167	0.213	0.261
3.	VVMNNG	0.441	0.431	0.325	0.132	0.153	0.264	0.319	0.267
4.	VPICTR	0.318	0.373	0.230	0.188	0.194	0.192	0.177	0.224
5.	SPATRL	0.211	0.375	0.277	0.086	0.199	0.170	0.254	0.159
6.	VISCON	0.448	0.444	0.397	0.075	0.109	0.249	0.320	0.256
7.	RSNGFG	0.192	0.328	0.218	0.055	0.119	0.094	0.163	0.138
8.	PRCPTN	0.187	0.421	0.421	0.405	0.338	0.124	0.260	0.209
9.	RINFOR	0.277	0.405	0.262	0.136	0.136	0.184	0.217	0.273
10.	AUDING	0.182	0.380	0.234	0.174	0.187	0.209	0.211	0.282
11.	AUDCON	0.366	0.409	0.417	0.162	0.204	0.161	0.216	0.186
12.	AFFIXS	0.383	0.505	0.314	0.187	0.196	0.197	0.255	0.322
13.	WDRCTX	0.403	0.512	0.422	0.103	0.189	0.218	0.279	0.232
14.	MSWRDS	0.513	0.473	0.389	0.175	0.178	0.221	0.229	0.250
15.	BLWRDS	0.456	0.417	0.405	0.148	0.110	0.287	0.310	0.244
16.	PHONIC	0.456	0.472	0.372	0.123	0.134	0.216	0.289	0.320
17.	SYLLAB	0.398	0.533	0.398	0.126	0.228	0.222	0.305	0.249
18.	AUDABS	0.445	0.370	0.378	0.117	0.177	0.244	0.293	0.189
19.	SPLREC	0.515	0.504	0.377	0.161	0.183	0.204	0.200	0.255
20.	SPDWRD	0.447	0.441	0.419	0.350	0.254	0.239	0.191	0.270
21.	RAFFRT	1.000	0.286	0.328	0.175	0.125	0.159	0.161	0.171
22.	RVRSLS	0.286	1.000	0.431	0.257	0.269	0.211	0.208	0.252
23.	VVABST	0.328	0.431	1.000	0.335	0.305	0.096	0.216	0.207
24.	DOTFGD	0.175	0.257	0.335	1.000	0.466	0.058	0.024	0.089
25.	CUESYC	0.125	0.269	0.305	0.466	1.000	0.094	0.024	0.113
26.	PITCHD	0.159	0.211	0.096	0.058	0.094	1.000	0.204	0.100
27.	RHYTHM	0.161	0.208	0.216	0.024	0.024	0.204	1.000	0.244
28.	INTNST	0.171	0.252	0.207	0.089	0.113	0.100	0.244	1.000

Table D
Correlation Matrix for Grade 6
N=159

		1 SPEED	2 POWER	3 VVMNNG	4 VPICTR	5 SPATRL	6 VISCON	7 RSNGFG	8 PRCPTN	9 RINFOR	10 AUDING	11 AUDCON
1.	SPEED	1.000	0.724	0.740	0.607	0.276	0.568	0.398	0.399	0.613	0.571	0.512
2.	POWER	0.724	1.000	0.832	0.577	0.356	0.689	0.428	0.327	0.642	0.600	0.582
3.	VVMNNG	0.740	0.832	1.000	0.637	0.377	0.720	0.424	0.343	0.666	0.599	0.610
4.	VPICTR	0.607	0.577	0.637	1.000	0.457	0.536	0.396	0.285	0.645	0.695	0.532
5.	SPATRL	0.276	0.356	0.377	0.457	1.000	0.458	0.502	0.265	0.357	0.442	0.386
6.	VISCON	0.568	0.689	0.720	0.536	0.458	1.000	0.500	0.346	0.507	0.490	0.627
7.	RSNGFG	0.398	0.428	0.424	0.396	0.502	0.500	1.000	0.390	0.404	0.468	0.471
8.	PRCPTN	0.399	0.327	0.343	0.285	0.265	0.346	0.390	1.000	0.274	0.313	0.327
9.	RINFOR	0.613	0.642	0.666	0.645	0.357	0.507	0.404	0.274	1.000	0.656	0.518
10.	AUDING	0.571	0.600	0.599	0.695	0.442	0.490	0.468	0.313	0.656	1.000	0.543
11.	AUDCON	0.512	0.582	0.610	0.532	0.386	0.627	0.471	0.327	0.518	0.543	1.000
12.	AFFIXS	0.740	0.783	0.831	0.660	0.379	0.715	0.407	0.338	0.686	0.567	0.598
13.	WDRCTX	0.609	0.710	0.759	0.476	0.320	0.677	0.309	0.315	0.553	0.429	0.570
14.	MSWRDS	0.685	0.783	0.811	0.465	0.324	0.697	0.400	0.335	0.568	0.511	0.571
15.	3LWRDS	0.612	0.665	0.769	0.518	0.368	0.565	0.362	0.242	0.617	0.545	0.574
16.	PHONIC	0.612	0.662	0.692	0.524	0.363	0.621	0.388	0.323	0.549	0.441	0.486
17.	SYLLAB	0.539	0.571	0.577	0.407	0.363	0.448	0.421	0.273	0.434	0.437	0.385
18.	AUDABS	0.598	0.575	0.666	0.420	0.253	0.559	0.308	0.314	0.482	0.446	0.466
19.	SPLREC	0.730	0.727	0.764	0.453	0.246	0.666	0.351	0.330	0.547	0.455	0.606
20.	SPDWRD	0.667	0.519	0.543	0.337	0.203	0.455	0.376	0.434	0.483	0.354	0.455
21.	RAFFRT	0.540	0.571	0.601	0.442	0.219	0.497	0.331	0.341	0.443	0.450	0.551
22.	RVRSLS	0.598	0.534	0.547	0.501	0.308	0.495	0.439	0.469	0.535	0.462	0.534
23.	VVABST	0.470	0.426	0.420	0.313	0.154	0.377	0.218	0.408	0.277	0.301	0.396
24.	DOTFGD	0.319	0.197	0.178	0.164	0.087	0.133	0.232	0.411	0.141	0.273	0.201
25.	CUESYC	0.360	0.313	0.329	0.403	0.296	0.189	0.309	0.389	0.252	0.257	0.227
26.	PITCHD	0.250	0.238	0.302	0.406	0.276	0.250	0.210	0.111	0.334	0.250	0.253
27.	RHYTHM	0.146	0.121	0.132	0.139	-0.015	0.177	0.092	0.081	0.100	0.129	0.082
28.	INTRST	0.330	0.357	0.415	0.287	0.201	0.400	0.259	0.208	0.306	0.332	0.285

Table D (Continued)
Correlation Matrix for Grade 6
N=159

		12 APFIXS	13 WDRCTX	14 MSWRDS	15 BLWRDS	16 PHONIC	17 SYLLAB	18 AUDABS	19 SPLREC	20 SPDWRD
1.	SPEED	0.740	0.609	0.685	0.612	0.612	0.539	0.598	0.730	0.667
2.	POWER	0.783	0.710	0.783	0.665	0.662	0.571	0.575	0.727	0.519
3.	VVMNNG	0.831	0.759	0.811	0.769	0.692	0.577	0.666	0.764	0.543
4.	VPICTR	0.660	0.476	0.465	0.518	0.524	0.407	0.420	0.453	0.337
5.	SPATRL	0.379	0.320	0.324	0.368	0.363	0.363	0.253	0.246	0.203
6.	VISCON	0.715	0.677	0.697	0.565	0.621	0.448	0.559	0.666	0.455
7.	RSNGPG	0.407	0.309	0.400	0.362	0.388	0.421	0.308	0.351	0.376
8.	PRCPTN	0.338	0.315	0.335	0.242	0.323	0.273	0.314	0.330	0.434
9.	RINFOR	0.686	0.553	0.568	0.617	0.549	0.434	0.482	0.547	0.483
10.	AUDING	0.567	0.429	0.511	0.545	0.441	0.437	0.446	0.455	0.354
11.	AUDCON	0.598	0.570	0.571	0.574	0.486	0.385	0.466	0.606	0.455
12.	APFIXS	1.000	0.725	0.762	0.717	0.728	0.567	0.605	0.751	0.568
13.	WDRCTX	0.725	1.000	0.779	0.634	0.614	0.506	0.552	0.716	0.515
14.	MSWRDS	0.762	0.779	1.000	0.716	0.687	0.559	0.612	0.832	0.549
15.	BLWRDS	0.717	0.634	0.716	1.000	0.707	0.565	0.679	0.679	0.459
16.	PHONIC	0.728	0.614	0.687	0.707	1.000	0.605	0.699	0.642	0.471
17.	SYLLAB	0.567	0.506	0.559	0.565	0.605	1.000	0.596	0.555	0.442
18.	AUDABS	0.605	0.552	0.612	0.679	0.699	0.596	1.000	0.614	0.439
19.	SPLREC	0.751	0.716	0.832	0.679	0.642	0.555	0.614	1.000	0.666
20.	SPDWRD	0.568	0.515	0.549	0.459	0.471	0.442	0.439	0.666	1.000
21.	RAFFRT	0.550	0.551	0.601	0.530	0.443	0.452	0.502	0.564	0.478
22.	RVRSLS	0.601	0.560	0.568	0.480	0.561	0.522	0.507	0.636	0.650
23.	VVABST	0.364	0.443	0.447	0.275	0.382	0.366	0.375	0.507	0.472
24.	DOTPGD	0.184	0.158	0.215	0.191	0.174	0.271	0.222	0.228	0.275
25.	CUESYC	0.303	0.216	0.278	0.336	0.300	0.310	0.344	0.241	0.256
26.	PITCHD	0.322	0.215	0.235	0.345	0.296	0.232	0.209	0.195	0.174
27.	RHYTHM	0.163	0.189	0.181	0.150	0.224	0.101	0.051	0.190	0.240
28.	INTHST	0.359	0.370	0.376	0.353	0.427	0.306	0.361	0.341	0.363

Table D (Continued)
Correlation Matrix for Grade 6
N=159

		21 RAPFRT	22 RVRSLS	23 VVABST	24 DOTFGD	25 CUESYC	26 PITCHD	27 RHYTHM	28 INTNST
1.	SPEED	0.540	0.598	0.470	0.319	0.360	0.250	0.146	0.330
2.	POWER	0.571	0.534	0.426	0.197	0.313	0.238	0.121	0.357
3.	VMNMNG	0.601	0.547	0.420	0.178	0.329	0.302	0.132	0.415
4.	VPICTR	0.442	0.501	0.313	0.164	0.403	0.406	0.139	0.287
5.	SPATRL	0.219	0.308	0.154	0.087	0.296	0.276	-0.015	0.201
6.	VISCON	0.497	0.495	0.377	0.133	0.189	0.250	0.177	0.400
7.	RSNGFG	0.331	0.439	0.218	0.232	0.309	0.210	0.092	0.259
8.	PRCPTN	0.341	0.469	0.408	0.411	0.389	0.111	0.081	0.208
9.	RINFOR	0.443	0.535	0.277	0.141	0.252	0.334	0.100	0.306
10.	AUDING	0.450	0.462	0.301	0.273	0.257	0.250	0.129	0.332
11.	AUDCOM	0.551	0.534	0.396	0.201	0.227	0.253	0.082	0.285
12.	AFFIXS	0.550	0.601	0.364	0.184	0.303	0.322	0.163	0.359
13.	WDRCTX	0.551	0.560	0.443	0.158	0.216	0.215	0.189	0.370
14.	NUMWDS	0.601	0.568	0.447	0.215	0.278	0.235	0.181	0.376
15.	BLNWDS	0.530	0.480	0.275	0.191	0.336	0.345	0.150	0.353
16.	PHONIC	0.443	0.561	0.382	0.174	0.300	0.296	0.224	0.427
17.	SYLLAB	0.452	0.522	0.366	0.271	0.310	0.232	0.101	0.306
18.	AUDABS	0.502	0.507	0.375	0.222	0.344	0.209	0.051	0.361
19.	SPLREC	0.564	0.636	0.507	0.228	0.241	0.195	0.190	0.341
20.	SPDWRD	0.478	0.650	0.472	0.275	0.256	0.174	0.240	0.363
21.	RAPFRT	1.000	0.500	0.490	0.268	0.305	0.201	0.022	0.329
22.	RVRSLS	0.500	1.000	0.516	0.262	0.321	0.231	0.208	0.357
23.	VVABST	0.490	0.516	1.000	0.400	0.464	0.141	0.032	0.236
24.	DOTFGD	0.268	0.262	0.400	1.000	0.495	0.128	0.035	0.051
25.	CUESYC	0.305	0.321	0.464	0.495	1.000	0.232	-0.048	0.159
26.	PITCHD	0.201	0.231	0.141	0.128	0.232	1.000	0.195	0.318
27.	RHYTHM	0.022	0.208	0.032	0.035	-0.048	0.195	1.000	0.200
28.	INTNST	0.329	0.357	0.236	0.051	0.159	0.318	0.200	1.000

Table E

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Speed of Reading

Grade 3, N=223

Substrata Factor Level 0	Predictor Level I	r_o	$V^2/2$	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
Speed of Reading	Speed Word Perception	.5837	.3407	.6593	1.0045	.6623	.3377	.5811	0.40	22.81
	Vis. Verbal Meaning	.5347	.0763	.5830	1.0091	.5883	.4117	.6416	0.28	14.36
	Dot Configuration	.2219	.0256	.5575	1.0137	.5651	.4349	.6595	0.14	2.93
	Recog. Affixes-Roots	.4763	.0178	.5396	1.0183	.5495	.4505	.6712	0.19	9.00
	Word Reversals	.1594	.0188	.5209	1.0230	.5329	.4671	.6835	−0.15	−2.37

(Continued)

Table E (Continued)

Speed of Reading, Grade 3

From Speed of Reading at Level 0 to:

Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Speed of Word Perception	Spelling Recognition	.6211	.3858	.6142	1.0045	.6170	.3830	.6189	0.28	17.01
	Visual Abstraction	.4963	.0346	.5796	1.0091	.5849	.4151	.6443	0.17	8.18
	Speed Vis. Perception	.3687	.0232	.5565	1.0137	.5641	.4359	.6602	0.17	6.08
	Matching Word Sounds	.5959	.0240	.5325	1.0183	.5422	.4578	.6766	0.25	14.51
Visual Verbal Meaning	Spelling Recognition	.7308	.5340	.4660	1.0045	.4681	.5319	.7293	0.35	25.63
	Auditory Abstraction	.6128	.0639	.4021	1.0091	.4057	.5943	.7709	0.22	13.15
	Meaning of Affixes	.5885	.0289	.3732	1.0137	.3783	.6217	.7885	0.18	10.36
	Aud. Picture Meaning	.4510	.0185	.3547	1.0183	.3612	.6388	.7992	0.14	6.33
	Vis. Verbal Concept.	.6342	.0115	.3432	1.0230	.3511	.6489	.8055	0.15	9.42
Dot Fig.-Ground Configuration	Cue Symbol Closure	.3613	.1305	.8695	1.0045	.8734	.1266	.3558	0.32	11.11
	Auding	.2572	.0351	.8344	1.0091	.8420	.1580	.3975	0.19	4.70
Recog. Affixes and Roots	Spelling Recognition	.5870	.3445	.6555	1.0045	.6584	.3416	.5844	0.32	18.13
	Vis. Verbal Concept.	.5384	.0432	.6122	1.0091	.6178	.3822	.6182	0.22	11.41
	Blend Word Elements	.5351	.0212	.5911	1.0137	.5992	.4008	.6331	0.20	10.55
Word Reversals	Blend Word Elements	.5373	.2887	.7113	1.0045	.7145	.2855	.5343	0.39	20.45
	Speed Vis. Perception	.3722	.0432	.6681	1.0091	.6742	.3258	.5708	0.20	7.35
	Visual Abstraction	.4073	.0205	.6477	1.0137	.6565	.3435	.5861	0.17	6.55

(Continued)

Table E (Continued)

Speed of Reading, Grade 3

From Speed of Reading Through Speed of Word Perception at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Spelling Recognition	Word Recog. Context	.7327	.5269	.4631	1.0045	.4652	.5348	.7313	0.42	30.56
	Aud. Verbal Concept.	.6667	.0781	.3850	1.0091	.3885	.6115	.7820	0.26	17.31
	Syllabication	.5643	.0265	.3585	1.0137	.3634	.6366	.7979	0.16	9.04
	Phonics	.5625	.0131	.3454	1.0183	.3518	.6482	.8051	0.14	7.91
Visual Verbal Abstraction	(Analysis Completed)									
Speed of Visual Perception	(Analysis Completed)									
Matching Word Sounds	Word Recog. Context	.8123	.6596	.3404	1.0045	.3420	.6580	.8112	0.61	49.10
	Phonics	.6244	.0534	.2870	1.0091	.2896	.7104	.8428	0.24	15.09
	Aud. Verbal Concept.	.6319	.0163	.2708	1.0137	.2745	.7255	.8518	0.19	12.00
	Spatial Relations	.2155	.0120	.2588	1.0183	.2635	.7365	.8582	−0.12	−2.54

(Continued)

Table E (Continued)

Speed of Reading, Grade 3

Substrata Factor Level II	Predictor Level III	From Speed of Reading Through Visual Verbal Meaning at Level I to:								
		r_o	V^2/Z	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{K}^2$	$\bar{K}$	β	$\sqrt{F_o}$
Spelling Recognition	(Analysis Completed)									
Auditory Verbal Abstraction	Phonics	.5930	.3516	.6484	1.0045	.6513	.3487	.5905	0.35	20.55
	Word Recog. Context	.5886	.1055	.5429	1.0091	.5478	.4522	.6725	0.29	16.59
	Aud. Verbal Concept.	.5312	.0224	.5205	1.0137	.5276	.4724	.6873	0.19	10.09
Meaning of Affixes	(Analysis Completed)									
Auditory Picture Meaning	Range of Information	.5170	.2673	.7327	1.0045	.7360	.2640	.5138	0.47	23.60
	Spatial Relations	.3127	.0317	.7010	1.0091	.7074	.2926	.5409	0.19	5.67
Visual Verbal Concept.	Aud. Verbal Concept.	.7328	.5385	.4615	1.0045	.4636	.5364	.7324	0.48	34.78
	Word Recog. Context	.6787	.0863	.3752	1.0091	.3786	.6214	.7883	0.36	23.06
	Spatial Relations	.6229	.0159	.3593	1.0137	.3642	.6358	.7974	0.14	5.74

(Continued)

Table E (Continued)

Speed of Reading, Grade 3

From Speed of Reading Through Dot Figure-Ground Configuration at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-n-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Cue Symbol Closure	(Analysis Completed)									
	Range of Information	.5699	.3248	.6752	1.0045	.6783	.3217	.5672	0.47	26.40
Auding	Spatial Relations	.4197	.0752	.6000	1.0091	.6055	.3945	.6281	0.20	8.31
	Reasoning Vis. Fig.	.3916	.0244	.5757	1.0137	.5835	.4165	.6453	0.18	6.94

From Speed of Reading Through Recog. of Affixes and Roots at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-n-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Spelling Recognition	(Analysis Completed)									
Visual Verbal Concept.	(Analysis Completed)									
	Word Recog. Context	.6748	.4554	.5446	1.0045	.5471	.4529	.6730	0.42	28.14
Blending Word Elements	Syllabication	.5601	.0724	.4722	1.0091	.4765	.5235	.7235	0.23	12.56
	Aud. Verbal Concept.	.6008	.0271	[illegible]	1.0137	.4512	.5488	.7408	0.21	12.56
	Tonal Intensity	.2427	.0180	[illegible]	1.0183	.4349	.5651	.7517	0.14	3.26

(Continued)

Table E (Continued)

Speed of Reading, Grade 3

From Speed of Reading Through Word Reversals at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Blending Word Elements	(Analysis Completed)									
Speed of Visual Perception	(Analysis Completed)									
Visual Verbal Abstraction	(Analysis Completed)									

Table F

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Speed of Reading

Grade 4, N=283

Substrata Factor Level 0	Predictor Level I	r_o	V^2/N	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
	Meaning of Affixes	.6413	.4113	.5887	1.0036	.5908	.4092	.6397	0.30	19.05
	Speed Word Perception	.5822	.0976	.4911	1.0071	.4946	.5054	.7109	0.28	15.96
Speed of Reading	Spelling Recognition	.6367	.0286	.4625	1.0108	.4674	.5326	.7298	0.24	14.96
	Aud. Picture Meaning	.4639	.0141	.4483	1.0144	.4548	.5452	.7384	0.17	7.65
	Spatial Relations	.0970	.0185	.4299	1.0181	.4376	.5624	.7499	-0.15	-1.39

(Continued)

Table F (Continued)

Speed of Reading, Grade 4

From Speed of Reading at Level 0 to:										
Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Meaning of Affixes	Vis. Verbal Meaning	.7671	.5884	.4116	1.0036	.4130	.5870	.7661	0.36	27.42
	Word Recog. Context	.6738	.0545	.3571	1.0071	.3596	.6404	.8002	0.20	13.32
	Phonics	.6929	.0310	.3261	1.0108	.3296	.6704	.8188	0.17	11.44
	Auding	.5175	.0208	.3053	1.0144	.3097	.6903	.8308	0.16	8.39
	Syllabication	.6236	.0138	.2915	1.0181	.2968	.7032	.8386	0.16	9.76
Speed of Word Perception	Visual Abstraction	.5361	.2874	.7126	1.0036	.7151	.2849	.5338	0.30	15.97
	Word Recog. Context	.4999	.0851	.6274	1.0071	.6319	.3681	.6067	0.23	11.23
	Dot Configuration	.2526	.0246	.6028	1.0108	.6093	.3907	.6250	0.17	4.14
	Vis. Verbal Meaning	.4903	.0236	.5793	1.0144	.5876	.4124	.6422	0.21	9.89
Spelling Recognition	Matching Word Sounds	.7519	.5653	.4347	1.0036	.4362	.5638	.7509	0.24	18.13
	Visual Abstraction	.5911	.0589	.3758	1.0071	.3785	.6215	.7884	0.22	12.64
	Word Recog. Context	.7165	.0404	.3354	1.0108	.3391	.6609	.8130	0.25	17.60
	Syllabication	.6285	.0173	.3181	1.0144	.3227	.6773	.8230	0.15	9.23
	Vis. Verbal Meaning	.6819	.0114	.3068	1.0181	.3123	.6877	.8293	0.17	11.17
Auditory Picture Meaning	Auding	.6441	.4149	.5851	1.0036	.5872	.4128	.6425	0.42	26.57
	Vis. Verbal Meaning	.5242	.0658	.5193	1.0071	.5230	.4770	.6906	0.20	10.48
	Pitch Discrimination	.3318	.0190	.5004	1.0108	.5057	.4943	.7030	0.14	4.59
	Range of Information	.5522	.0163	.4841	1.0144	.4910	.5090	.7134	0.17	9.24
Spatial Relations	Reasoning Vis. Fig.	.4681	.2191	.7809	1.0036	.7836	.2164	.4652	0.35	16.14
	Word Reversals	.4244	.0619	.7189	1.0071	.7241	.2759	.5253	0.27	11.46

(Continued)

Table F (Continued)

Speed of Reading, Grade 4

From Speed of Reading Through Meaning of Affixes at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Visual Verbal Meaning	Auditory Abstraction	.6428	.4131	.5869	1.0036	.5890	.4110	.6411	0.32	20.32
	Vis. Verbal Concept.	.6287	.1033	.4836	1.0071	.4871	.5129	.7162	0.32	19.96
	Blend Word Elements	.6284	.0176	.4660	1.0108	.4710	.5290	.7273	0.20	12.62
Word Recognition Context	Blend Word Elements	.7037	.4953	.5047	1.0036	.5065	.4935	.7025	0.45	31.41
	Vis. Verbal Concept.	.6235	.0539	.4508	1.0071	.4540	.5460	.7389	0.26	16.31
	Recog. Affixes-Roots	.5406	.0154	.4354	1.0108	.4401	.5599	.7483	0.15	8.28
Phonics	Auditory Abstraction	.7242	.5245	.4755	1.0036	.4772	.5228	.7230	0.38	27.03
	Blend Word Elements	.6868	.0628	.4128	1.0071	.4157	.5843	.7644	0.23	15.94
	Recog. Affixes-Roots	.5980	.0218	.3910	1.0108	.3952	.6048	.7777	0.17	9.98
	Vis. Verbal Concept.	.5910	.0121	.3788	1.0144	.3843	.6157	.7847	0.15	8.63
Auding	Aud. Verbal Concept.	.5298	.2807	.7193	1.0036	.7219	.2781	.5274	0.34	17.44
	Tonal Intensity	.3242	.0411	.6782	1.0071	.6830	.3170	.5630	0.18	5.77
	Cue-Symbol Closure	.3164	.0320	.6461	1.0108	.6531	.3469	.5890	0.17	5.31
	Vis. Verbal Concept.	.4548	.0223	.6239	1.0144	.6328	.3672	.6059	0.18	8.19
Syllabication	Blend Word Elements	.5849	.3422	.6578	1.0036	.6602	.3398	.5829	0.27	15.83
	Vis. Verbal Concept.	.5712	.0682	.5896	1.0071	.5938	.4062	.6373	0.28	15.95
	Recog. Affixes-Roots	.5293	.0352	.5545	1.0108	.5604	.4396	.6630	0.23	12.18

(Continued)

Table F (Continued)

Speed of Reading, Grade 4

From Speed of Reading Through Speed of Word Perception at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{K}^2$	$\bar{K}$	β	βr_o
Visual Verbal Abstraction	Recog. Affixes-Roots	.5216	.2721	.7279	1.0036	.7305	.2695	.5192	0.28	14.47
	Aud. Verbal Concept.	.4738	.0728	.6550	1.0071	.6597	.3403	.5833	0.20	9.21
	Speed Vis. Perception	.4022	.0411	.6139	1.0108	.6205	.3795	.6160	0.19	7.49
	Blend Word Elements	.5012	.0156	.5983	1.0144	.6069	.3931	.6270	0.17	8.14
Word Recognition in Context	(Analysis Completed)									
Dot Figure-Ground Configuration	(Analysis Completed)									
Visual Verbal Meaning	(Analysis Completed)									

From Speed of Reading Through Spelling Recognition at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{K}^2$	$\bar{K}$	β	βr_o
Matching Word Sounds	Blend Word Elements	.7234	.5379	.4621	1.0036	.4638	.5362	.7323	0.37	26.86
	Vis. Verbal Concept.	.6758	.0760	.3862	1.0071	.3889	.6111	.7817	0.26	17.43
	Auditory Abstraction	.6636	.0228	.3634	1.0108	.3673	.6327	.7954	0.19	12.47
	Aud. Verbal Concept.	.5687	.0105	.3528	1.0144	.3579	.6421	.8013	0.13	7.45
Visual Verbal Abstraction	(Analysis Completed)									
Word Recognition in Context	(Analysis Completed)									

(Continued)

Table F (Continued)

Speed of Reading, Grade 4

From Speed of Reading Through Spelling Recognition at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Σ	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{\bar{R}}^2$	$\bar{\bar{R}}$	β	$\overline{\beta r_o}$
Syllabication	(Analysis Completed)									
Visual Verbal Meaning	(Analysis Completed)									
From Speed of Reading Through Auditory Picture Meaning at Level I to:										
Auding	(Analysis Completed)									
Visual Verbal Meaning	(Analysis Completed)									
Pitch Discrim.	(Analysis Completed)									
Range of Info.	(Analysis Completed)									
From Speed of Reading Through Spatial Relations at Level I to:										
Reasoning with Visual Figures	(Analysis Completed)									
Word Reversals	(Analysis Completed)									

Table C

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Speed of Reading

Grade 5, N=242

Substrata Factor Level 0	Predictor Level I	r_o	$V^2/2$	R^2	$\frac{N-1}{N-n-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
	Spelling Recognition	.6651	.4423	.5577	1.0038	.5598	.4402	.6635	0.24	15.57
	Speed Word Perception	.5586	.0677	.4900	1.0077	.4937	.5063	.7115	0.25	13.52
Speed of Reading	Vis. Verbal Meaning	.6425	.0574	.4326	1.0116	.4376	.5624	.7499	0.31	19.69
	Auditory Abstraction	.3594	.0113	.4212	1.0156	.4278	.5722	.7565	-0.18	-6.21
	Visual Abstraction	.4290	.0162	.4050	1.0195	.4129	.5871	.7662	0.15	6.21
	Meaning of Affixes	.6366	.0107	.3943	1.0235	.4036	.5964	.7723	0.17	10.86

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

	From Speed of Reading at Level 0 to:								
Substrata Factor Level I	Predictor Level II	r_o	V^2/N	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{k}^2$	$\bar{k}$	β	$\overline{PV}_o$
Spelling Recognition	Matching Word Sounds	.7799	.6082	.3918	1.0038	.3933	.6067	.7789	0.31	24.11
	Word Recog. Context	.7525	.0536	.3382	1.0077	.3409	.6591	.8119	0.32	23.83
	Blend Word Elements	.7120	.0215	.3168	1.0116	.3205	.6795	.8243	0.20	14.25
	Recog. Affixes-Roots	.5151	.0130	.3037	1.0156	.3085	.6915	.8316	0.13	6.87
Speed of Word Perception	Matching Word Sounds	.4624	.2138	.7862	1.0038	.7893	.2107	.4591	0.20	8.76
	Speed Vis. Perception	.4077	.0984	.6879	1.0077	.6932	.3068	.5539	0.19	7.49
	Recog. Affixes-Roots	.4469	.0472	.6407	1.0116	.6481	.3519	.5932	0.24	10.32
	Dot Configuration	.3498	.0227	.6180	1.0156	.6276	.3724	.6102	0.16	5.30
	Word Reversals	.4410	.0172	.6008	1.0195	.6125	.3875	.6225	0.16	6.88
Visual Verbal Meaning	Matching Word Sounds	.7432	.5523	.4477	1.0038	.4494	.5506	.7420	0.40	29.73
	Aud. Picture Meaning	.6935	.1507	.2970	1.0077	.2993	.7007	.8371	0.33	22.70
	Vis. Verbal Concept.	.6683	.0215	.2755	1.0116	.2787	.7213	.8493	0.14	9.40
	Range of Information	.6640	.0086	.2668	1.0156	.2710	.7290	.8538	0.13	8.76
	Rhythm Discrimination	.3193	.0080	.2588	1.0195	.2639	.7361	.8580	0.09	3.00
Auditory Verbal Abstraction	Phonics	.7055	.4978	.5022	1.0038	.5041	.4959	.7042	0.46	32.20
	Blend Word Elements	.6424	.0393	.4629	1.0077	.4665	.5335	.7304	0.23	14.85
	Aud. Verbal Concept.	.5204	.0141	.4489	1.0116	.4541	.5459	.7389	0.15	7.54

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

From Speed of Reading at Level 0 to:										
Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Visual Verbal Abstraction	Word Reversals	.4312	.1859	.8141	1.0038	.8172	.1828	.4275	0.16	6.54
	Aud. Verbal Concept.	.4169	.0695	.7445	1.0077	.7503	.2497	.4997	0.17	6.85
	Speed Vis. Perception	.4205	.0544	.6902	1.0116	.6982	.3018	.5494	0.21	8.48
	Blend Word Elements	.4053	.0232	.6670	1.0156	.6774	.3226	.5680	0.18	7.13
	Dot Configuration	.3351	.0199	.6471	1.0195	.6598	.3402	.5833	0.16	5.01
Meaning of Affixes	Word Recog. Context	.6980	.4873	.5127	1.0038	.5147	.4853	.6966	0.30	21.02
	Aud. Picture Meaning	.6190	.1235	.3892	1.0077	.3922	.6078	.7796	0.19	11.95
	Phonics	.6623	.0385	.3507	1.0116	.3547	.6453	.8033	0.20	13.09
	Range of Information	.6472	.0210	.3296	1.0156	.3348	.6652	.8156	0.18	11.36
	Vis. Verbal Concept.	.6678	.0101	.3195	1.0195	.3258	.6742	.8211	0.15	9.99

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	R^2	$\frac{N-1}{N-n-1}$	$\overline{R}^2$	$\overline{E}^2$	$\overline{E}$	β	$\overline{\beta r_o}$
From Speed of Reading Through Spelling Recognition at Level I to:										
Matching Word Sounds	Syllabication	.5803	.3367	.6633	1.0038	.6658	.3342	.5781	0.53	30.25
	Auding	.3363	.0356	.6277	1.0077	.6326	.3674	.6061	0.20	6.49
Word Recognition in Context	Syllabication	.5197	.2701	.7299	1.0038	.7328	.2672	.5170	0.46	23.40
	Auding	.3542	.0501	.6798	1.0077	.6851	.3149	.5612	0.23	8.09
Blending Word Elements	Syllabication	.5669	.3214	.6786	1.0038	.6812	.3188	.5646	0.48	26.72
	Auding	.3692	.0512	.6274	1.0077	.6322	.3678	.6065	0.21	7.71
	Pitch Discrimination	.2874	.0172	.6101	1.0116	.6172	.3828	.6187	0.14	3.85
Recognition of Affixes and Roots	(Analysis Completed)									
From Speed of Reading Through Speed of Word Perception at Level I to:										
Matching Word Sounds	(Analysis Completed)									
Speed of Visual Perception	(Analysis Completed)									
Recognition of Affixes and Roots	(Analysis Completed)									

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

Substrata Factor Level II	Predictor Level III	r_o	V^2/E	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{E}^2$	$\bar{E}$	β	$\sqrt{F_o}$
From Speed of Reading Through Speed of Word Perception at Level I to:										
Dot Figure-Ground Configuration	(Analysis Completed)									
Word Reversals	(Analysis Completed)									
From Speed of Reading Through Visual Verbal Meaning at Level I to:										
Matching Word Sounds	(Analysis Completed)									
Auditory Picture Meaning	(Analysis Completed)									
Visual Verbal Concept.	Syllabication	.5045	.2545	.7455	1.0038	.7483	.2517	.5017	0.37	10.19
	Auding	.4275	.0925	.6530	1.0077	.6580	.3420	.5848	0.26	10.11
	Reasoning Vis. Fig.	.4417	.0478	.6052	1.0116	.6123	.3877	.6227	0.26	10.48
Range of Information	Auding	.6630	.4396	.5604	1.0038	.5625	.4375	.6614	0.60	20.40
	Syllabication	.3953	.0515	.5089	1.0077	.5128	.4872	.6980	0.26	9.23
Rhythm Discrimination	(Analysis Completed)									

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

From Speed of Reading Through Auditory Verbal Abstraction at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{K}^2$	$\bar{K}$	β	$\overline{F_o}$
Phonics	Syllabication	.6638	.4407	.5593	1.0038	.5615	.4385	.6622	0.60	39.55
	Auding	.3973	.0524	.5070	1.0077	.5109	.4891	.6994	0.24	9.36
Blending Word Elements	(Analysis Completed)									
Auditory Verbal Concept.	Syllabication	.4320	.1866	.8134	1.0038	.8165	.1835	.4283	0.34	14.55
	Auding	.4244	.1030	.7104	1.0077	.7159	.2841	.5330	0.33	13.86

From Speed of Reading Through Visual Verbal Abstraction at Level I to:

Word Reversals	(Analysis Completed)
Auditory Verbal Concept.	(Analysis Completed)
Speed of Visual Perception	(Analysis Completed)
Blending Word Elements	(Analysis Completed)
Dot Figure-Ground Configuration	(Analysis Completed)

(Continued)

Table G (Continued)

Speed of Reading, Grade 5

From Speed of Reading Through Meaning of Affixes at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\sqrt{r_o}$
Word Recognition in Context	(Analysis Completed)									
Auditory Picture Meaning	(Analysis Completed)									
Phonics	(Analysis Completed)									
Range of Information	(Analysis Completed)									
Visual Verbal Concept.	(Analysis Completed)									

Table 8

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Speed of Reading

Grade 6, N=119

Substrata Factor Level 0	Predictor Level I	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{k}^2$	$\bar{k}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
	Vis. Verbal Meaning	.7397	.5471	.4529	1.0064	.4558	.5442	.7377	0.24	17.56
	Speed Word Perception	.6647	.0996	.3533	1.0128	.3579	.6421	.8013	0.29	19.36
Speed of Reading	Aud. Picture Meaning	.6072	.0327	.3206	1.0194	.3268	.6732	.8205	0.25	14.83
	Spelling Recognition	.7305	.0187	.3019	1.0260	.3098	.6902	.8308	0.24	17.33

(Continued)

Table H (Continued)

Speed of Reading, Grade 6

From Speed of Reading at Level 0 to:

Substrata Factor Level I	Predictor Level II	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{K}^2$	$\bar{K}$	β	$\overline{\beta r_o}$
Visual Verbal Meaning	Meaning of Affixes	.8310	.6906	.3094	1.0064	.3113	.6887	.8299	0.34	28.25
	Matching Word Sounds	.8113	.0755	.2339	1.0128	.2369	.7631	.8736	0.27	21.89
	Blend Word Elements	.7695	.0248	.2091	1.0194	.2131	.7869	.8871	0.25	18.89
	Vis. Verbal Concept.	.7201	.0093	.1998	1.0260	.2050	.7950	.8916	0.15	10.47
Speed of Word Perception	Word Reversals	.6499	.4224	.5776	1.0064	.5812	.4188	.6471	0.48	30.92
	Meaning of Affixes	.5684	.0495	.5281	1.0128	.5348	.4652	.6820	0.28	15.59
Auditory Picture Meaning	Auding	.6952	.4833	.5167	1.0064	.5200	.4800	.6928	0.47	31.90
	Meaning of Affixes	.6597	.1038	.4129	1.0128	.4182	.5818	.7628	0.30	19.59
	Cue-Symbol Closure	.4029	.0295	.3834	1.0194	.3909	.6091	.7805	0.23	9.13
	Pitch Discrimination	.4061	.0221	.3614	1.0260	.3708	.6292	.7932	0.16	6.31
	Dot Configuration	.1641	.0172	.3442	1.0327	.3554	.6446	.8028	-0.15	-2.48
Spelling Recognition	Matching Word Sounds	.8319	.6920	.3080	1.0064	.3099	.6901	.8307	0.57	47.01
	Word Reversals	.6364	.0395	.2684	1.0128	.2719	.7281	.8533	0.19	12.12
	Meaning of Affixes	.7510	.0154	.2530	1.0194	.2579	.7421	.8615	0.20	15.08

(Continued)

Table H (Continued)

Speed of Reading, Grade 6

Substrata Factor Level II	Predictor Level III	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r}_o$
From Speed of Reading Through Visual Verbal Meaning at Level I to:										
	Phonics	.7285	.5307	.4693	1.0064	.4723	.5277	.7264	0.35	25.44
Meaning of Affixes	Word Recog. Context	.7253	.1240	.3453	1.0128	.3497	.6503	.8064	0.34	24.51
	Range of Information	.6864	.0581	.2872	1.0194	.2928	.7072	.8410	0.31	20.77
Matching Word Sounds	Word Recog. Context	.7787	.6063	.3937	1.0064	.3962	.6038	.7770	0.48	37.27
	Phonics	.6869	.0700	.3237	1.0128	.3279	.6721	.8198	0.30	20.54
	Recog. Affixes-Roots	.6008	.0275	.2962	1.0194	.3020	.6980	.8355	0.20	12.00
	Phonics	.7067	.4994	.5006	1.0064	.5037	.4963	.7045	0.30	21.15
Blending Word Elements	Range of Information	.6165	.0748	.4257	1.0128	.4312	.5688	.7542	0.22	13.52
	Auditory Abstraction	.6782	.0470	.3788	1.0194	.3861	.6139	.7835	0.27	18.33
	Aud. Verbal Concept.	.5745	.0222	.3565	1.0260	.3658	.6342	.7964	0.18	10.42
	Word Recog. Context	.6760	.4580	.5420	1.0064	.5454	.4546	.6742	0.35	23.50
Visual Verbal Conceptualization	Reasoning Vis. Fig.	.5004	.0936	.4483	1.0128	.4541	.5459	.7389	0.20	9.88
	Aud. Verbal Concept.	.6265	.0368	.4115	1.0194	.4195	.5805	.7619	0.23	13.88
	Phonics	.6212	.0249	.3866	1.0260	.3966	.6034	.7781	0.22	13.27

(Continued)

Table 8 (Continued)

Speed of Reading, Grade 6

From Speed of Reading Through Speed of Word Perception at Level I to:

Substrata Factor Level II	Predictor Level III	r_{o}	V^2/S	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\hat{R}^2$	$\hat{R}$	β	$\overline{\beta r}_{o}$
Word Reversals	(Analysis Completed)									
Meaning of Affixes	(Analysis Completed)									

From Speed of Reading Through Auditory Picture Meaning at Level I to:

Substrata Factor Level II	Predictor Level III	r_{o}	V^2/S	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\hat{R}^2$	$\hat{R}$	β	$\overline{\beta r}_{o}$
Auding	Range of Information	.6556	.4298	.3702	1.0066	.3738	.6242	.6528	0.67	30.37
	Aud. Verbal Concept.	.5624	.0562	.5160	1.0129	.5206	.6786	.6826	0.23	12.05
	Spatial Relations	.6623	.0282	.4057	1.0186	.4051	.5069	.7135	0.19	8.07
Meaning of Affixes	(Analysis Completed)									
Cue Symbol Closure	(Analysis Completed)									
Pitch Discrimination	(Analysis Completed)									
Dot Figure Ground Configuration	(Analysis Completed)									

(Continued)

Table H (Continued)

Speed of Reading, Grade 6

From Speed of Reading Through Spelling Recognition at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/N	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{\bar{R}}^2$	$\bar{\bar{R}}$	β	$\overline{\beta r_o}$
Matching Word Sounds	(Analysis Completed)									
Word Reversals	(Analysis Completed)									
Meaning of Affixes	(Analysis Completed)									

Table 3

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Power of Reading

Grade 3, N=223

Substrata Factor Level 0	Predictor Level I	r_o	$V^2/2$	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\hat{R}^2$	$\hat{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
	Word Recog. Context	.7267	.5281	.4719	1.0045	.4740	.5260	.7252	0.36	25.77
	Vis. Verbal Meaning	.6848	.0769	.3969	1.0091	.4006	.5996	.7742	0.23	15.80
Power of Reading	Aud. Verbal Concept.	.6376	.0337	.3632	1.0137	.3682	.6318	.7948	0.16	9.77
	Auding	.4769	.0189	.3443	1.0183	.3506	.6494	.8058	0.16	7.43
	Syllabication	.5466	.0134	.3329	1.0230	.3405	.6595	.8121	0.13	7.18

(Continued)

Table I (Continued)

Power of Reading, Grade 3

From Power of Reading at Level 0 to:

Substrata Factor Level I	Predictor Level II	r_o	$V^2/2$	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Word Recognition in Context	Matching Word Sounds	.8121	.6596	.3404	1.0045	.3420	.6580	.8112	0.55	44.76
	Vis. Verbal Concept.	.6707	.0366	.3038	1.0091	.3066	.6934	.8327	0.21	13.93
	Blend Word Elements	.6768	.0172	.2867	1.0137	.2906	.7094	.8422	0.18	12.26
Visual Verbal Meaning	Spelling Recognition	.7308	.5340	.4660	1.0045	.4681	.5319	.7293	0.35	25.63
	Auditory Abstraction	.6120	.0639	.4021	1.0091	.4057	.5943	.7709	0.22	13.15
	Meaning of Affixes	.5885	.0289	.3732	1.0137	.3783	.6217	.7885	0.18	10.36
	Aud. Picture Meaning	.4510	.0185	.3547	1.0183	.3612	.6388	.7992	0.14	6.33
	Vis. Verbal Concept.	.6342	.0115	.3432	1.0230	.3511	.6489	.8055	0.15	9.42
Auditory Verbal Concept.	Vis. Verbal Concept.	.7330	.5385	.4615	1.0045	.4636	.5364	.7324	0.46	33.76
	Spelling Recognition	.6667	.0632	.3983	1.0091	.4019	.5981	.7734	0.32	21.25
	Reasoning Vis. Fig.	.4522	.0147	.3836	1.0137	.3889	.6111	.7818	0.14	6.10
Auding	Range of Information	.5699	.3248	.6752	1.0045	.6783	.3217	.5672	0.31	17.53
	Aud. Picture Meaning	.5404	.0824	.5928	1.0091	.5982	.4018	.6339	0.30	16.12
	Reasoning Vis. Fig.	.3916	.0637	.5291	1.0137	.5363	.4637	.6809	0.20	7.76
	Speed Vis. Perception	.4183	.0258	.5033	1.0183	.5125	.4875	.6982	0.18	7.34
Syllabication	Spelling Recognition	.5643	.3185	.6815	1.0045	.6846	.3154	.5616	0.26	14.52
	Blend Word Elements	.5601	.0633	.6183	1.0091	.6239	.3761	.6133	0.25	13.64
	Visual Abstraction	.4723	.0214	.5969	1.0137	.6050	.3950	.6285	0.19	8.57
	Pitch Discrimination	.3117	.0183	.5785	1.0183	.5891	.4109	.6410	0.14	4.35

(Continued)

Table I (Continued)

Power of Reading, Grade 3

From Power of Reading Through Word Recognition in Context at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Σ	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Matching Word Sounds	Phonics	.6244	.3899	.6101	1.0045	.6128	.3872	.6222	0.39	23.89
	Recog. Affixes-Roots	.5792	.1469	.4632	1.0091	.4674	.5326	.7298	0.32	18.16
	Speed Word Perception	.5959	.0634	.3998	1.0137	.4053	.5947	.7712	0.29	17.41
Visual Verbal Concept.	Recog. Affixes-Roots	.5384	.2899	.7101	1.0045	.7133	.2867	.5355	0.37	19.67
	Phonics	.4810	.0966	.6135	1.0091	.6191	.3809	.6172	0.29	13.56
	Spatial Relations	.4229	.0610	.5525	1.0137	.5601	.4399	.6633	0.26	10.77
Blending Word Elements	Phonics	.5390	.2906	.7094	1.0045	.7126	.2874	.5361	0.31	16.26
	Word Reversals	.5373	.1441	.5653	1.0091	.5704	.4296	.6554	0.32	16.85
	Recog. Affixes-Roots	.5351	.0764	.4889	1.0137	.4956	.5044	.7102	0.30	15.67
	Tonal Intensity	.2427	.0171	.4719	1.0183	.4805	.5195	.7207	0.13	3.17

From Power of Reading Through Visual Verbal Meaning at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Σ	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Spelling Recognition	Speed Word Perception	.6[illegible]11	.3858	.6142	1.0045	.6170	.3830	.6189	0.35	21.71
	Recog. Affixes-Roots	.5870	.1262	.4880	1.0091	.4924	.5076	.7125	0.33	19.29
	Phonics	.5625	.0674	.4206	1.0137	.4263	.5737	.7574	0.29	16.36
Auditory Verbal Abstraction	Phonics	.5930	.3516	.6484	1.0045	.6513	.3487	.5905	0.46	26.94
	Recog. Affixes-Roots	.4361	.0587	.5897	1.0091	.5951	.4049	.6363	0.27	11.60
	Rhythm Discrimination	.2692	.0288	.5609	1.0137	.5686	.4314	.6568	0.17	4.59
Meaning of Affixes	(Analysis Completed)									

(Continued)

Table I (Continued)

Power of Reading, Grade 3

From Power of Reading Through Visual Verbal Meaning at Level I to:										
Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Aud. Picture. Meaning	Phonics	.3350	.1122	.8878	1.0045	.8918	.1082	.3290	0.28	8.81
	Spatial Relations	.3127	.0568	.8310	1.0091	.8385	.1615	.4019	0.25	7.34
Visual Verbal Concept.	(Analysis Completed)									
From Power of Reading Through Auditory Verbal Conceptualization at Level I to:										
Visual Verbal Concept.	(Analysis Completed)									
Spelling Recognition	(Analysis Completed)									
Reasoning with Visual Figures	(Analysis Completed)									

(Continued)

Table 1 (Continued)

Power of Reading, Grade 3

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
From Power of Reading Through Auding at Level I to:										
Range of Information	(Analysis Completed)									
Aud. Picture Meaning	(Analysis Completed)									
Reasoning with Visual Figures	(Analysis Completed)									
Speed Visual Perception	(Analysis Completed)									
From Power of Reading Through Syllabication at Level I to:										
Spelling Recognition	(Analysis Completed)									
Blending Word Elements	(Analysis Completed)									
Visual Verbal Abstraction	(Analysis Completed)									
Pitch Discrimination	(Analysis Completed)									

Table J

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Power of Reading

Grade 4, N=283

Substrata Factor Level 0	Predictor Level I	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
Power of Reading	Vis. Verbal Meaning	.7586	.5755	.4245	1.0036	.4260	.5740	.7576	0.25	18.61
	Word Recog. Context	.7038	.0783	.3462	1.0071	.3487	.6513	.8071	0.17	11.59
	Vis. Verbal Concept.	.6750	.0268	.3194	1.0108	.3229	.6771	.8229	0.13	8.60
	Meaning of Affixes	.7412	.0170	.3025	1.0144	.3068	.6932	.8326	0.16	11.42
	Auding	.5132	.0099	.2925	1.0181	.2978	.7022	.8380	0.13	6.46
	Matching Word Sounds	.7499	.0112	.2814	1.0217	.2875	.7125	.8441	0.20	14.56

(Continued)

Table J (Continued)

Power of Reading, Grade 4

From Power of Reading at Level 0 to:

Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Visual Verbal Meaning	Phonics	.6868	.4716	.5284	1.0036	.5302	.4698	.6854	0.22	15.13
	Spelling Recognition	.6819	.0968	.4316	1.0071	.4346	.5654	.7519	0.30	20.22
	Range of Information	.5474	.0414	.3902	1.0108	.3944	.6056	.7782	0.16	8.86
	Auditory Abstraction	.6428	.0154	.3748	1.0144	.3802	.6198	.7873	0.18	11.39
	Aud. Picture Meaning	.[illegible]242	.0139	.3610	1.0181	.3675	.6325	.7953	0.15	7.65
Word Recognition in Context	Spelling Recognition	.7165	.5133	.4867	1.0036	.4884	.5116	.7153	0.40	28.58
	Blend Word Elements	.7037	.0809	.4058	1.0071	.4087	.5913	.7690	0.33	23.35
	Word Reversals	.5178	.0286	.3772	1.0108	.3812	.6188	.7866	0.19	9.94
Visual Verbal Concept.	Blend Word Elements	.6295	.3963	.6037	1.0036	.6059	.3941	.6278	0.31	19.04
	Aud. Verbal Concept.	.5793	.0890	.5147	1.0071	.5184	.4816	.6940	0.26	14.91
	Syllabication	.5712	.0360	.4788	1.0108	.4839	.5161	.7184	0.22	12.27
	Reasoning Vis. Fig.	.4467	.0267	.4521	1.0144	.4586	.5414	.7358	0.18	7.92
Meaning of Affixes	Phonics	.6929	.4801	.5199	1.0036	.5217	.4783	.6916	0.25	16.96
	Range of Information	.5768	.0893	.4305	1.0071	.4336	.5664	.7526	0.17	9.47
	Spelling Recognition	.6671	.0502	.3803	1.0108	.3844	.6156	.7846	0.20	12.88
	Aud. Picture Meaning	.5664	.0252	.3551	1.0144	.3602	.6398	.7999	0.19	10.78
	Syllabication	.6236	.0191	.3360	1.0181	.3421	.6579	.8111	0.17	10.53
	Word Reversals	.4872	.0138	.3222	1.0217	.3292	.6708	.8190	0.13	6.45
Auding	Aud. Picture Meaning	.6441	.4149	.5851	1.0036	.5872	.4128	.6425	0.39	24.88
	Reasoning Vis. Fig.	.4412	.0781	.5070	1.0071	.5106	.4894	.6996	0.19	8.16
	Range of Information	.5775	.0434	.4637	1.0108	.4686	.5314	.7289	0.19	11.11
	Tonal Intensity	.3242	.0301	.4335	1.0144	.4398	.5602	.7485	0.16	5.05
	Aud. Verbal Concept.	.5298	.0182	.4153	1.0181	.4228	.5772	.7597	0.16	8.52
Matching Word Sounds	Spelling Recognition	.7519	.5653	.4347	1.0036	.4362	.5638	.7509	0.34	25.55
	Phonics	.7109	.0863	.3484	1.0071	.3509	.6491	.8057	0.25	17.43
	Blend Word Elements	.7334	.0334	.3150	1.0108	.3184	.6816	.8256	0.26	18.93
	Aud. Verbal Concept	.5697	.0107	.3043	1.0144	.3087	.6913	.8314	0.13	7.22

Table J (Continued)

Power of Reading, Grade 4

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
From Power of Reading Through Visual Verbal Meaning at Level I to:										
Phonics	Recog. Affixes-Roots	.5980	.3577	.6423	1.0036	.6446	.3554	.5961	0.45	26.58
	Pitch Discrimination	.3580	.0672	.5752	1.0071	.5793	.4207	.6486	0.26	9.19
	Visual Abstraction	.4597	.0285	.5467	1.0108	.5526	.4474	.6689	0.20	8.98
Spelling Recognition	Visual Abstraction	.5911	.3494	.6506	1.0036	.6529	.3471	.5891	0.27	15.56
	Recog. Affixes-Roots	.5890	.1082	.5424	1.0071	.5463	.4537	.6736	0.32	18.44
	Speed Word Perception	.5831	.0601	.4823	1.0108	.4875	.5125	.7159	0.30	17.25
Range of Information	(Analysis Completed)									
Auditory Verbal Abstraction	Recog. Affixes-Roots	.5944	.3533	.6467	1.0036	.6490	.3510	.5925	0.55	32.06
	Speed Vis. Perception	.3263	.0261	.6206	1.0071	.6250	.3750	.6124	0.17	5.44
Auditory Picture Meaning	Pitch Discrimination	.3318	.1101	.8899	1.0036	.8931	.1069	.3270	0.27	8.45
	Recog. Affixes-Roots	.3004	.0610	.8289	1.0071	.8348	.1652	.4065	0.20	5.74
	Spatial Relations	.2902	.0311	.7978	1.0108	.8064	.1936	.4400	0.19	5.17
From Power of Reading Through Word Recognition in Context at Level I to:										
Spelling Recognition	(Analysis Completed)									

(Continued)

Table J (Continued)

Power of Reading, Grade 4

From Power of Reading Through Word Recognition in Context at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Blending Word Elements	Recog. Affixes-Roots	.5682	.3228	.6772	1.0036	.6796	.3204	.5661	0.39	21.76
	Speed Word Perception	.5033	.0773	.5998	1.0071	.6041	.3959	.6292	0.25	12.45
	Speed Vis. Perception	.3824	.0245	.5753	1.0108	.5815	.4185	.6469	0.15	5.64
	Pitch Discrimination	.2672	.0151	.5603	1.0144	.5683	.4317	.6570	0.13	3.32
Word Reversals	Spatial Relations	.4244	.1801	.8199	1.0036	.8228	.1772	.4209	0.26	10.90
	Speed Word Perception	.4234	.1256	.6943	1.0071	.6992	.3008	.5484	0.27	11.35
	Rhythm Discrimination	.3578	.0464	.6479	1.0108	.6549	.3451	.5875	0.21	7.37
	Speed Vis. Perception	.4128	.0230	.6249	1.0144	.6339	.3661	.6051	0.17	6.98
From Power of Reading Through Visual Verbal Conceptualization at Level I to:										
Blending Word Elements	(Analysis Completed)									
Auditory Verbal Concept	Visual Abstraction	.4758	.2264	.7736	1.0036	.7763	.2237	.4729	0.32	14.66
	Rhythm Discrimination	.3385	.0655	.7081	1.0071	.7131	.2869	.5356	0.16	5.33
	Spatial Relations	.3239	.0405	.6675	1.0108	.6747	.3253	.5704	0.16	5.03
	Pitch Discrimination	.2771	.0238	.6437	1.0144	.6529	.3471	.5891	0.15	4.03
	Recog. Affixes-Roots	.4501	.0185	.6252	1.0181	.6365	.3635	.6029	0.17	7.31
Syllabication	Recog. Affixes-Roots	.5293	.2801	.7199	1.0036	.7225	.2775	.5268	0.34	17.76
	Visual Abstraction	.4769	.0554	.6645	1.0071	.6692	.3308	.5751	0.20	9.29
	Speed Word Perception	.4460	.0233	.6412	1.0108	.6481	.3519	.5933	0.19	8.14

(Continued)

Table J (Continued)

Power of Reading, Grade 4

From Power of Reading Through Visual Verbal Conceptualization at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Reasoning with Visual Figures	Spatial Relations	.4681	.2191	.7809	1.0036	.7836	.2164	.4652	0.33	14.91
	Speed Vis. Perception	.4189	.0708	.7101	1.0071	.7151	.2849	.5337	0.25	10.24
	Recog. Affixes-Roots	.3392	.0254	.6846	1.0108	.6920	.3080	.5550	0.17	5.65

From Power of Reading Through Meaning of Affixes at Level I to:

Phonics	(Analysis Completed)
Range of Information	(Analysis Completed)
Spelling Recognition	(Analysis Completed)
Auditory Picture Meaning	(Analysis Completed)
Syllabication	(Analysis Completed)
Word Reversals	(Analysis Completed)

(Continued)

Table J (Continued)

Power of Reading, Grade 4

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
From Power of Reading Through Auding at Level I to:										
Auditory Picture Meaning	(Analysis Completed)									
Reasoning with Visual Figures	(Analysis Completed)									
Range of Information	(Analysis Completed)									
Tonal Intensity	(Analysis Completed)									
Auditory Verbal Concept.	(Analysis Completed)									
From Power of Reading Through Matching Word Sounds at Level I to:										
Spelling Recognition	(Analysis Completed)									
Phonics	(Analysis Completed)									
Blending Word Elements	(Analysis Completed)									
Auditory Verbal Concept.	(Analysis Completed)									

Table K

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Power of Reading

Grade 5, N=262

Substrata Factor Level 0	Predictor Level I	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
	Meaning of Affixes	.7631	.5823	.4177	1.0038	.4193	.5807	.7620	0.26	19.95
	Vis. Verbal Meaning	.7485	.0657	.3520	1.0077	.3547	.6453	.8033	0.24	17.87
Power of Reading	Word Recog. Context	.6989	.0270	.3250	1.0116	.3288	.6712	.8193	0.21	14.28
	Auding	.5411	.0144	.3106	1.0156	.3154	.6846	.8274	0.15	7.86
	Blend Word Elements	.6621	.0091	.3014	1.0195	.3073	.6927	.8323	0.14	9.31

(Continued)

Table K (Continued)

Power of Reading, Grade 5

From Power of Reading at Level 0 to:

Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Meaning of Affixes	Spelling Recognition	.7146	.5106	.4894	1.0038	.4913	.5087	.7132	0.32	22.91
	Range of Information	.6472	.1124	.3771	1.0077	.3800	.6200	.7874	0.18	11.66
	Vis. Verbal Concept.	.6678	.0281	.3490	1.0116	.3530	.6470	.8043	0.19	12.30
	Aud. Picture Meaning	.6190	.0235	.3255	1.0156	.3306	.6694	.8182	0.19	11.55
	Phonics	.6623	.0093	.3162	1.0195	.3224	.6776	.8232	0.14	9.34
Visual Verbal Meaning	Matching Word Sounds	.7432	.5523	.4477	1.0038	.4494	.5506	.7420	0.24	17.97
	Aud. Picture Meaning	.6935	.1507	.2970	1.0077	.2993	.7007	.8371	0.33	22.70
	Auditory Abstraction	.6089	.0228	.2742	1.0116	.2774	.7226	.8500	0.15	9.07
	Spelling Recognition	.7081	.0179	.2563	1.0156	.2603	.7397	.8601	0.20	14.09
	Range of Information	.6640	.0096	.2467	1.0195	.2515	.7485	.8652	0.13	8.78
	Rhythm Discrimination	.3193	.0077	.2390	1.0235	.2446	.7554	.8691	0.09	2.92
Word Recognition in Context	Matching Word Sounds	.7786	.6063	.3937	1.0038	.3952	.6048	.7777	0.40	30.67
	Spelling Recognition	.7525	.0538	.3399	1.0077	.3425	.6575	.8109	0.31	22.96
	Vis. Verbal Concept.	.6738	.0243	.3156	1.0116	.3193	.6807	.8251	0.22	14.44
Auding	Aud. Picture Meaning	.7007	.4909	.5091	1.0038	.5110	.4890	.6993	0.41	28.34
	Range of Information	.6630	.0647	.4444	1.0077	.4478	.5522	.7431	0.33	21.72
	Spatial Relations	.4342	.0293	.4151	1.0116	.4199	.5801	.7616	0.18	7.95
Blending Word Elements	Matching Word Sounds	.7462	.5568	.4432	1.0038	.4449	.5551	.7451	0.21	15.56
	Phonics	.7137	.0532	.3900	1.0077	.3930	.6070	.7791	0.18	12.57
	Vis. Verbal Concept.	.6646	.0316	.3584	1.0116	.3625	.6375	.7984	0.19	12.68
	Spelling Recognition	.7120	.0163	.3421	1.0156	.3474	.6526	.8078	0.22	15.44
	Auditory Abstraction	.6424	.0116	.3305	1.0195	.3369	.6631	.8143	0.16	10.06

(Continued)

Table K (Continued)

Power of Reading, Grade 5

From Power of Reading Through Meaning of Affixes at Level I to:

Substrata Factor Level II	Predictors Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
	Aud. Verbal Concept.	.5575	.3108	.6892	1.0038	.6919	.3081	.5551	0.29	15.69
Spelling Recognition	Syllabication	.5526	.1195	.5697	1.0077	.5741	.4259	.6526	0.22	11.95
	Recog. Affixes-Roots	.5151	.0603	.5094	1.0116	.5153	.4847	.6962	0.27	13.59
	Word Reversals	.5039	.0253	.4840	1.0156	.4915	.5085	.7131	0.19	9.62
Range of Information	Aud. Verbal Concept.	.4858	.2360	.7640	1.0038	.7669	.2331	.4828	0.37	17.49
	Word Reversals	.4049	.0512	.7128	1.0077	.7183	.2817	.5307	0.22	8.52
	Tonal Intensity	.2733	.0209	.6919	1.0116	.6999	.3001	.5478	0.15	4.00
	Aud. Verbal Concept.	.5825	.3393	.6607	1.0038	.6632	.3368	.5803	0.35	19.79
Visual Verbal Concept.	Syllabication	.5045	.0786	.5821	1.0077	.5865	.4135	.6430	0.21	10.39
	Reasoning Vis. Fig.	.4417	.0452	.5368	1.0116	.5431	.4569	.6760	0.22	9.76
	Recog. Affixes-Roots	.4485	.0304	.5064	1.0156	.5143	.4857	.6969	0.20	8.64
Auditory Picture Meaning	Aud. Verbal Concept.	.4639	.2152	.7848	1.0038	.7878	.2122	.4606	0.33	14.74
	Syllabication	.3899	.0441	.7407	1.0077	.7464	.2536	.5036	0.21	7.95
	Speed Vis. Perception	.3053	.0258	.7149	1.0116	.7232	.2768	.5261	0.17	4.98
	Syllabication	.6638	.4407	.5593	1.0038	.5615	.4385	.6622	0.46	30.05
Phonics	Aud. Verbal Concept.	.5345	.0755	.4838	1.0077	.4876	.5124	.7158	0.25	13.43
	Recog. Affixes-Roots	.4561	.0221	.4617	1.0116	.4671	.5329	.7300	0.16	7.12
	Tonal Intensity	.3196	.0159	.4458	1.0156	.4528	.5472	.7397	0.13	4.13

(Continued)

Table K (Continued)

Power of Reading, Grade 5

From Power of Reading Through Visual Verbal Meaning at Level I to:

Substrata Factor Level II	Predictors Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Matching Word Sounds	Syllabication	.5803	.3367	.6633	1.0038	.6658	.3342	.5781	0.33	19.12
	Aud. Verbal Concept.	.5721	.1270	.5362	1.0077	.5404	.4596	.6779	0.33	18.88
	Recog. Affixes-Roots	.5135	.0533	.4830	1.0116	.4886	.5114	.7151	0.26	13.14
Auditory Picture Meaning	(Analysis Completed)									
Auditory Verbal Abstraction	Syllabication	.5445	.2964	.7036	1.0038	.7063	.2937	.5420	0.33	17.87
	Aud. Verbal Concept.	.5204	.1000	.6035	1.0077	.6082	.3918	.6259	0.30	15.50
	Recog. Affixes-Roots	.4454	.0324	.5711	1.0116	.5778	.4222	.6498	0.20	8.85
Spelling Recognition	(Analysis Completed)									
Range of Information	(Analysis Completed)									
Rhythm Discrimination	(Analysis Completed)									

(Continued)

Table K (Continued)

Power of Reading, Grade 5

From Power of Reading Through Word Recognition in Context at Level I to:										
Substrata Factor Level II	Predictors Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\overline{K}^2$	$\overline{R}^2$	$\overline{R}$	β	$\overline{\beta r_o}$
Matching Word Sounds	(Analysis Completed)									
Spelling Recognition	(Analysis Completed)									
Visual Verbal Concept.	(Analysis Completed)									
From Power of Reading Through Auding at Level I to:										
Auditory Picture Meaning	(Analysis Completed)									
Range of Information	(Analysis Completed)									
Spatial Relations	Reasoning Vis. Fig.	.4034	.1627	.8373	1.0038	.8405	.1595	.3994	0.31	12.34
	Word Reversals	.3753	.0662	.7711	1.0077	.7771	.2229	.4722	0.27	9.95

(Continued)

Table K (Continued)

Power of Reading, Grade 5

From Power of Reading Through Blending Word Elements at Level I to:

Substrata Factor Level II	Predictors Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Matching Word Sounds	(Analysis Completed)									
Phonics	(Analysis Completed)									
Visual Verbal Concept.	(Analysis Completed)									
Spelling Recognition	(Analysis Completed)									
Auditory Verbal Abstraction	(Analysis Completed)									

Table L

Results of Wherry-Doolittle-Holmes Simple Structure Substrata Analysis for

Power of Reading

Grade 6, N=159

Substrata Factor Level O	Predictor Level I	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	Beta Weight β	Adjusted % Contrib. to Variance $\overline{\beta r_o}$
Power of Reading	Vis. Verbal Meaning	.8316	.6915	.3085	1.0064	.3104	.6896	.8304	0.44	36.04
	Matching Word Sounds	.7831	.0344	.2741	1.0128	.2776	.7224	.8500	0.26	20.24
	Meaning of Affixes	.7825	.0141	.2600	1.0194	.2650	.7350	.8573	0.22	17.22

(Continued)

Table L (Continued)

Power of Reading, Grade 6

From Power of Reading at Level I to:

Substrata Factor Level I	Predictor Level II	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Visual Verbal Meaning	Blend Word Elements	.7695	.5921	.4079	1.0064	.4105	.5895	.7678	0.29	22.47
	Word Recog. Context	.7586	.1226	.2853	1.0128	.2889	.7111	.8432	0.22	16.36
	Aud. Picture Meaning	.6367	.0421	.2432	1.0194	.2479	.7521	.8672	0.20	12.59
	Spelling Recognition	.7644	.0275	.2157	1.0260	.2213	.7787	.8824	0.21	16.17
	Vis. Verbal Concept.	.7201	.0107	.2050	1.0327	.2117	.7883	.8879	0.16	11.23
Matching Word Sounds	Spelling Recognition	.8319	.6920	.3080	1.0064	.3099	.6901	.8307	0.47	39.18
	Word Recog. Context	.7787	.0686	.2394	1.0128	.2425	.7575	.8704	0.32	24.53
	Blend Word Elements	.7159	.0185	.2209	1.0194	.2251	.7749	.8803	0.19	13.78
Meaning of Affixes	Spelling Recognition	.7510	.5639	.4361	1.0064	.4388	.5612	.7491	0.28	20.84
	Aud. Picture Meaning	.6597	.1284	.3076	1.0128	.3116	.6884	.8297	0.22	14.23
	Phonics	.7285	.0449	.2627	1.0194	.2678	.7322	.8557	0.23	16.48
	Word Recog. Context	.7253	.0204	.2424	1.0260	.2487	.7513	.8668	0.19	13.74
	Range of Information	.6864	.0125	.2299	1.0327	.2374	.7626	.8733	0.16	10.97

(Continued)

Table L (Continued)

Power of Reading, Grade 6

From Power of Reading Through Visual Verbal Meaning at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	K^2	$\frac{N-1}{N-m-1}$	$\bar{K}^2$	$\bar{R}^2$	$\bar{R}$	β	$\overline{\beta r_o}$
Blending Word Elements	Auditory Abstraction	.6792	.4614	.5386	1.0064	.5421	.4579	.6767	0.46	30.96
	Aud. Verbal Concept.	.5745	.0850	.4536	1.0128	.4595	.5405	.7352	0.22	12.61
	Auding	.5451	.0264	.4273	1.0194	.4355	.5645	.7513	0.18	9.64
	Pitch Discrimination	.3449	.0195	.4078	1.0260	.4184	.5816	.7626	0.15	4.95
Word Recognition in Context	Aud. Verbal Concept.	.5696	.3245	.6755	1.0064	.6798	.3202	.5658	0.30	16.80
	Auditory Abstraction	.5515	.1045	.5710	1.0128	.5783	.4217	.6494	0.28	15.15
	Word Reversals	.5603	.0415	.5295	1.0194	.5397	.4603	.6784	0.26	14.07
Auditory Picture Meaning	Auding	.6952	.4833	.5167	1.0064	.5200	.4800	.6928	0.55	37.78
	Pitch Discrimination	.4061	.0574	.4593	1.0128	.4651	.5349	.7313	0.19	7.70
	Cue Symbol Closure	.4029	.0369	.4223	1.0194	.4305	.5695	.7547	0.25	9.93
	Dot Configuration	.1641	.0212	.4011	1.0260	.4116	.5884	.7671	-0.18	-2.90
	Word Reversals	.5006	.0203	.3808	1.0327	.3933	.6067	.7789	0.17	8.16
Spelling Recognition	Speed Word Perception	.6665	.4442	.5558	1.0064	.5593	.4407	.6638	0.41	26.70
	Auditory Abstraction	.6135	.1275	.4282	1.0128	.4337	.5663	.7525	0.31	18.51
	Aud. Verbal Concept.	.6062	.0551	.3731	1.0194	.3803	.6197	.7872	0.28	16.75
Visual Verbal Concept.	Aud. Verbal Concept.	.6265	.3925	.6075	1.0064	.6114	.3886	.6234	0.39	23.99
	Auditory Abstraction	.5589	.0910	.5164	1.0128	.5231	.4769	.6906	0.32	17.57
	Spatial Relations	.4583	.0435	.4730	1.0194	.4821	.5179	.7196	0.23	10.22

(Continued)

Table 1 (Continued)

Power of Reading, Grade 6

From Power of Reading Through Matching Word Sounds at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{\bar{R}}^2$	$\bar{R}$	β	$\overline{Fr}_o$
Spelling Recognition	(Analysis Completed)									
Word Recognition in Context	(Analysis Completed)									
Blending Word Elements	(Analysis Completed)									

From Power of Reading Through Meaning of Affixes at Level I to:

Substrata Factor Level II	Predictor Level III	r_o	V^2/Z	R^2	$\frac{N-1}{N-m-1}$	$\bar{R}^2$	$\bar{\bar{R}}^2$	$\bar{R}$	β	$\overline{Fr}_o$
Spelling Recognition	(Analysis Completed)									
Auditory Picture Meaning	(Analysis Completed)									
Phonics	Auditory Abstraction	.6995	.4893	.5107	1.0064	.5140	.4860	.6972	0.47	32.51
	Word Reversals	.5612	.0575	.4532	1.0128	.4590	.5410	.7355	0.18	9.94
	Syllabication	.6047	.0276	.4256	1.0194	.4339	.5661	.7524	0.21	12.72
	Rhythm Discrimination	.2242	.0189	.4067	1.0260	.4173	.5827	.7634	0.14	3.10
Word Recognition in Context	(Analysis Completed)									
Range of Information	(Analysis Completed)									

TABLE M

RECTILINEAR AND CURVILINEAR COEFFICIENTS COMPUTED BETWEEN EACH VARIABLE AND SPEED OF READING AT EACH GRADE LEVEL[a]

No.	Name	Grade 3 N = 223		Grade 4 N = 283		Grade 5 N = 262		Grade 6 N = 159	
Variables		r	η	r	η	r	η	r	η
03	VVMNNG	.53	.56	.63	.63	.64	.69	.74	.80
04	VPICTR	.26	.32	.46	.51	.47	.50	.60	.62
05	SPATRL	.18	.35	.09	.18	.13	.20	.27	.35
06	VISCON	.40	.46	.49	.53	.49	.53	.56	.72
07	RSNGFG	.16	.31	.17	.20	.15	.22	.39	.46
08	PRCPTN	.26	.35	.28	.30	.31	.37	.39	.47
09	RINFOR	.30	.39	.48	.49	.53	.54	.61	.67
10	AUDING	.24	.29	.36	.39	.34	.36	.50	.56
11	AUDCON	.43	.46	.41	.43	.45	.50	.51	.60
12	AFFIXS	.41	.44	.59	.60	.59	.62	.70	.73
13	WDRCTX	.44	.47	.52	.54	.57	.64	.60	.69
14	MWDSND	.49	.52	.55	.57	.61	.68	.68	.78
15	BLWRDS	.33	.37	.51	.53	.52	.59	.61	.73
16	PHONIC	.33	.36	.49	.50	.47	.51	.57	.62
17	SYLLAB	.38	.43	.48	.49	.39	.43	.53	.59
18	AUDABS	.35	.36	.45	.44	.35	.42	.59	.65
19	SPLREC	.55	.57	.63	.63	.66	.70	.73	.77
20	SPDWRD	.48	.49	.52	.54	.47	.53	.55	.62
21	RAFFRT	.47	.49	.40	.41	.37	.42	.54	.64
22	RVRSLS	.15	.27	.33	.39	.47	.50	.59	.61
23	VVABST	.45	.48	.45	.48	.42	.45	.47	.51
24	DOTFGD	.22	.28	.22	.32	.27	.31	.31	.42
25	CUESYC	.17	.28	.27	.29	.24	.28	.36	.42
26	PITCHD	.17	.23	.24	.31	.16	.26	.25	.35
27	RHYTHM	-.02	.24	.19	.29	.16	.24	.14	.36
28	INTNST	-.05	.17	.20	.28	.24	.25	.33	.41

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[a] To conserve space, only the regression of y on x is given for the eta correlation coefficient. None of the chi-square differences between the rectilinear and the curvilinear coefficients for either the regression of y on x or x on y was statistically significant even at the 5% level. Therefore, the bivariate distributions are essentially linear.

TABLE N

RECTILINEAR AND CURVILINEAR COEFFICIENTS COMPUTED BETWEEN EACH VARIABLE AND POWER OF READING AT EACH GRADE LEVEL[a]

No.	Name	Grade 3 N = 223		Grade 4 N = 283		Grade 5 N = 262		Grade 6 N = 159	
Variables		r	η	r	η	r	η	r	η
03	VWMNNG	.68	.68	.75	.76	.74	.76	.83	.83
04	VPICTR	.41	.48	.49	.56	.61	.68	.57	.60
05	SPATRL	.41	.44	.30	.33	.27	.33	.35	.44
06	VISCON	.66	.67	.67	.68	.64	.67	.68	.72
07	RSNGFG	.37	.42	.31	.34	.27	.33	.42	.50
08	PRCPTN	.34	.36	.30	.33	.20	.25	.32	.44
09	RINFOR	.54	.57	.56	.57	.60	.66	.64	.64
10	AUDING	.43	.46	.45	.49	.49	.54	.53	.57
11	AUDCON	.63	.65	.58	.58	.59	.64	.58	.59
12	AFFIXS	.46	.51	.69	.71	.71	.73	.74	.76
13	WDRCTX	.72	.74	.70	.72	.69	.73	.71	.74
14	MWDSND	.69	.72	.75	.76	.70	.73	.78	.82
15	BLWRDS	.65	.66	.68	.69	.66	.69	.66	.69
16	PHONIC	.50	.53	.59	.62	.60	.63	.63	.64
17	SYLLAB	.54	.60	59	.61	.46	.49	.57	.57
18	AUDABS	.60	.61	.59	.60	.50	.53	.57	.58
19	SPLREC	.68	.69	.68	.68	.65	.67	.72	.72
20	SPDWRD	.39	.42	.42	.43	.29	.32	.46	.49
21	RAFFRT	.53	.55	.53	.55	.37	.41	.57	.60
22	RVRSLS	.39	.42	.46	.47	.44	.47	.53	.55
23	VVABST	.49	.54	.44	.48	.34	.39	.42	.47
24	DOTPUD	.03	.21	.02	.16	.14	.23	.19	.25
25	CUESYC	.03	.20	.18	.30	.16	.23	.31	.44
26	PITCHD	.24	.31	.26	.33	.16	.29	.23	.36
27	RHYTHM	.21	.26	.25	.29	.21	.33	.12	.21
28	INTNST	.16	.20	.21	.27	.26	.30	.35	.41

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[a] To conserve space, only the regression of y on x is given for the eta correlation coefficient. None of the chi-square differences between the rectilinear and the curvilinear coefficients for either the regression of y on x or x on y was statistically significant even at the 5% level. Therefore, the bivariate distributions are essentially linear.

TABLE O

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR BOYS VS. GIRLS

No.	Name	Grade 3				Grade 4			
		Boys N= 122		Girls N = 101		Boys N= 128		Girls N = 155	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	14.3	6.5	16.7	7.1 **	19.1	7.5	20.5	7.6
02	POWER	8.7	7.4	10.6	6.2 *	14.4	9.1	16.6	7.1 *
Ind. Var.									
03	VMNGNG	12.5	6.6	13.4	5.2	17.3	7.9	19.2	6.6 *
04	VPICTR	15.7	4.4	14.9	3.9	20.1	5.2	19.4	5.0
05	SPATRL	14.3	4.6	14.3	4.3	16.1	4.6	15.5	4.0
06	VISCON	12.6	5.0	14.2	5.3 *	16.2	5.1	17.8	4.5 **
07	RSNGFG	14.9	5.2	15.9	4.6	17.3	4.4	18.6	3.9 *
08	PRCPTN	17.4	7.2	17.7	6.6	22.4	7.6	24.2	7.9
09	RINFOR	17.0	4.6	16.7	4.8	20.7	5.8	20.1	4.5
10	AUDING	70.3	15.1	69.9	14.0	84.7	16.7	84.1	14.4
11	AUDCOM	4.5	3.2	5.5	3.5	6.2	3.1	6.7	2.7
12	AFFIXS	16.5	6.7	16.8	6.9	22.0	9.3	24.0	8.2
13	WDRCTX	27.9	14.2	34.4	14.7 **	36.8	14.5	44.7	12.2 **
14	MSNGWD	26.2	13.8	31.6	15.7 **	36.2	15.6	42.5	14.3 **
15	BLWRDS	25.6	8.8	26.7	8.8	30.1	8.5	33.3	7.3 **
16	PHONIC	15.3	8.9	14.3	8.5	20.0	11.9	23.5	12.6 *
17	SYLLAB	3.2	2.6	3.3	2.4	4.4	3.2	5.6	3.1 **
18	AUDABS	10.4	6.9	11.4	6.0	12.9	6.6	15.0	5.7 **
19	SPLREC	27.6	9.9	31.6	11.6 **	33.9	11.9	41.2	10.6 **
20	SPDWRD	26.7	8.8	29.0	9.9	33.7	12.5	39.4	13.0 **
21	RAFFRT	16.3	9.1	20.3	9.1 **	22.9	10.0	27.4	9.4 **
22	RVRSLS	7.8	5.6	8.4	6.1	10.7	6.9	12.1	6.2
23	VVABST	8.0	5.3	11.5	6.5 **	13.5	7.2	16.2	6.8 **
24	DOTFGD	47.7	10.6	48.1	10.5	49.8	12.4	52.8	10.6 *
25	CUESYC	23.6	8.1	22.0	7.6	25.8	8.7	26.4	8.5
26	PITCHD	15.6	4.5	15.2	4.0	17.5	5.7	16.6	5.5
27	RHYTHM	15.0	3.5	15.0	3.3	15.9	3.4	16.3	2.9
28	INTRST	13.5	4.3	12.3	4.2 *	14.8	4.4	14.5	3.6

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.

TABLE O--CONTINUED

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR BOYS VS. GIRLS

No.	Name	Grade 5				Grade 6			
		Boys		Girls		Boys		Girls	
		N= 140		N = 122		N = 76		N = 83	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	20.9	8.6	23.4	8.2 *	25.7	10.9	31.8	11.2 **
02	POWER	19.2	9.9	19.8	7.8	21.1	9.7	25.3	8.7 **
Ind. Var.									
03	VVMNNG	22.8	7.8	22.6	7.3	25.8	7.3	28.3	6.9 *
04	VPICTR	23.3	5.4	22.0	5.4	25.6	6.3	26.5	6.4
05	SPATRL	17.7	4.2	17.0	3.8	18.4	3.5	18.4	4.3
06	VISCON	18.1	4.9	19.1	4.0	19.4	4.5	20.9	4.1 *
07	RSNGFG	19.1	3.9	19.5	3.3	20.1	3.8	20.7	3.1
08	PRCPTN	24.1	8.4	25.6	8.5	26.9	8.4	32.7	6.0 **
09	RINFOR	24.5	5.7	23.4	5.1	26.3	5.8	27.4	5.4
10	AUDING	94.6	13.0	89.4	13.1 **	95.1	14.3	98.7	13.3
11	AUDCON	7.3	2.9	7.4	2.5	7.1	3.4	8.5	2.5 **
12	AFFIXS	28.2	10.5	27.5	8.5	32.2	9.7	35.6	10.3 *
13	WDRCTX	41.4	14.6	47.5	10.8 **	45.9	12.8	51.6	10.2 **
14	MSNDWD	42.2	14.8	46.3	12.9 *	46.9	12.9	51.4	10.8 *
15	BLWRDS	32.2	8.4	34.6	6.4 *	34.8	7.5	36.1	7.5
16	PHONIC	26.8	12.2	26.9	12.2	27.6	12.1	33.8	12.6 **
17	SYLLAB	5.9	3.9	6.3	3.6	6.8	3.4	8.1	3.7 *
18	AUDABS	15.3	6.3	15.2	5.4	16.2	5.5	18.6	5.3 **
19	SPLREC	40.4	12.4	45.5	10.2 **	46.8	11.9	52.3	11.5 **
20	SPDWRD	41.2	13.2	45.5	11.4 **	47.9	13.8	57.5	15.9 **
21	RAFFRT	28.9	9.5	31.4	9.0 *	33.0	9.0	37.2	7.7 **
22	RVRSLS	13.5	7.5	16.0	6.6 **	15.0	7.7	21.2	9.0 **
23	VVABST	18.2	9.0	21.0	8.1 **	19.5	7.8	25.3	8.0 **
24	DOTFGD	52.9	11.3	56.4	11.1 *	55.8	11.9	61.6	9.5 **
25	CUESYC	29.4	9.0	31.0	9.3	33.5	9.3	36.1	9.6
26	PITCHD	18.0	5.0	19.4	4.9 *	20.4	5.3	20.2	5.0
27	RHYTHM	17.1	2.9	17.4	2.5	18.5	2.8	18.4	2.6
28	INTNST	16.1	2.9	15.6	3.2	16.6	2.9	16.8	3.0

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.

TABLE P

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR SLOWEST VS. FASTEST READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 3				Grade 4			
		Fastest		Slowest		Fastest		Slowest	
		N = 52		N = 57		N = 71		N = 70	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	24.7	3.7	6.9	2.2 **	29.9	4.4	10.7	3.0 **
02	POWER	13.6	7.3	6.1	5.0 **	22.5	6.9	9.9	6.2 **
Ind. Var.									
03	VVMNNG	17.1	5.7	8.8	4.4 **	24.7	5.8	12.6	5.9 **
04	VPICTR	17.0	3.5	14.0	3.5 **	23.0	6.2	17.7	4.0 **
05	SPATRL	15.5	3.8	13.6	5.1 *	16.6	3.8	15.6	4.5
06	VISCON	15.8	4.6	10.1	4.0 **	20.4	3.7	13.9	4.7 **
07	RSNGFG	15.6	4.3	14.1	5.9	19.1	3.8	17.2	4.2 **
08	PRCPTN	19.5	7.4	14.8	6.3 **	26.2	6.8	20.5	8.2 **
09	RINFOR	19.5	4.7	15.4	4.1 **	24.2	4.4	17.7	4.5 **
10	AUDING	74.9	13.8	64.4	16.8 **	94.0	13.6	76.6	15.9 **
11	AUDCON	6.7	2.8	3.0	2.9 **	8.1	2.3	4.8	2.8 **
12	AFFIXS	21.2	6.2	13.0	6.2 **	31.0	8.1	17.1	6.2 **
13	WDRCTX	40.2	15.3	22.5	10.7 **	51.3	9.0	32.3	12.4 **
14	MSNDWD	39.2	15.7	19.7	10.5 **	50.5	10.4	27.0	12.1 **
15	BLWRDS	30.6	8.6	23.4	7.2 **	37.4	5.7	26.7	7.1 **
16	PHONIC	19.6	10.0	11.1	6.1 **	30.6	12.3	14.0	8.7 **
17	SYLLAB	4.7	3.0	2.4	1.6 **	7.3	3.0	3.4	2.4 **
18	AUDABS	13.9	6.5	8.2	5.4 **	17.9	4.9	10.3	5.9 **
19	SPLREC	37.7	11.6	21.5	6.6 **	48.8	9.2	28.6	8.3 **
20	SPDWRD	35.0	9.3	20.3	7.2 **	46.1	10.9	27.3	10.8 **
21	RAFFRT	24.8	8.9	12.6	6.5 **	31.0	8.9	20.3	8.1 **
22	RVRSLS	9.9	6.5	7.4	4.4 *	14.9	6.7	8.8	5.3 **
23	VVABST	13.8	6.2	6.3	4.5 **	19.4	6.4	10.8	6.2 **
24	DOTFGD	51.5	10.3	45.6	9.9 **	55.7	10.6	48.6	10.9 **
25	CUESYC	26.0	8.3	22.5	8.0 *	29.1	9.6	23.3	7.2 **
26	PITCHD	16.7	4.2	14.7	4.0 **	18.8	5.8	16.3	5.3 **
27	RHYTHM	14.6	3.3	15.5	3.8	17.1	2.6	15.6	3.5 **
28	INTNST	12.7	4.2	13.6	4.7	16.0	3.7	14.0	4.7 **

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.

TABLE P--CONTINUED

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR SLOWEST VS. FASTEST READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 5				Grade 6			
		Fastest		Slowest		Fastest		Slowest	
		N = 63		N = 66		N = 38		N = 38	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	33.6	6.5 -	12.3	2.9 **	44.3	5.4	14.7	4.1 **
02	POWER	26.1	7.6	12.0	7.6 **	31.7	5.2	13.1	8.1 **
Ind. Var.									
03	VVMSNG	29.0	4.7	16.3	6.3 **	33.1	2.7	18.8	7.0 **
04	VPICTR	26.1	5.2	20.2	4.8 **	30.8	5.4	21.1	6.0 **
05	SPATRL	18.0	4.1	17.2	3.9	19.4	3.7	17.2	4.2 *
06	VISCON	21.4	3.5	15.4	4.9 **	22.4	2.9	15.2	4.1 **
07	RSNGFG	20.2	3.6	18.7	4.0 *	21.9	2.5	18.4	3.8 **
08	PRCPTN	28.1	9.2	21.6	7.7 **	33.6	7.3	26.1	7.6 **
09	RINFOR	28.1	4.3	20.5	4.7 **	31.1	3.2	21.6	5.6 **
10	AUDING	99.7	10.9	87.2	14.2 **	106.0	9.3	86.5	17.1 **
11	AUDCON	9.0	2.2	5.7	2.7 **	9.4	2.1	5.3	3.2 **
12	AFFIXS	36.5	7.5	20.3	6.7 **	43.0	5.0	23.2	8.7 **
13	WDRCTX	53.5	7.1	31.7	12.6 **	56.4	5.6	36.8	11.2 **
14	MSNDWD	54.6	6.1	30.7	13.7 **	57.0	3.0	35.7	13.1 **
15	BLWRDS	38.2	4.6	26.9	8.4 **	39.8	3.0	28.7	8.7 **
16	PHONIC	34.8	11.0	18.6	9.8 **	39.3	9.3	19.9	9.0 **
17	SYLLAB	7.9	3.7	4.0	3.2 **	9.3	3.4	4.7	2.7 **
18	AUDABS	17.9	5.2	12.4	6.4 **	20.6	4.0	12.3	5.2 **
19	SPLREC	52.6	7.8	31.5	9.2 **	59.0	5.4	36.6	11.1 **
20	SPDWRD	51.6	12.4	33.6	9.3 **	67.1	14.9	39.3	9.7 **
21	RAFFRT	34.0	8.5	24.5	9.5 **	40.2	5.9	28.9	10.6 **
22	RVRSLS	20.0	7.2	11.1	6.2 **	25.2	9.6	12.1	6.5 **
23	VVABST	24.1	8.0	14.5	7.3 **	27.4	7.4	17.2	9.1 **
24	DOTFGD	57.6	12.7	51.2	10.7 **	62.7	10.2	55.6	12.9 **
25	CUESYC	33.0	9.9	27.0	6.9 **	38.8	10.2	31.3	8.9 **
26	PITCHD	19.9	4.7	17.8	4.6 **	21.9	5.3	19.3	5.0 *
27	RHYTHM	17.6	2.6	16.6	2.8 *	19.3	2.4	18.2	2.7
28	INTNST	16.9	2.8	15.0	3.0 **	17.8	2.5	15.6	3.8 **

*Difference is significant at the five per cent level.

**Difference is significant at the one per cent level.

TABLE Q

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR LEAST VS. MOST POWERFUL READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 3				Grade 4			
		Most Powerful N = 59		Least Powerful N = 59		Most Powerful N = 71		Least Powerful N = 73	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	19.7	6,6	13.0	6.3 **	26.7	6.8	14.9	6.4 **
02	POWER	19.1	3.8	1.8	1.5 **	25.9	3.8	5.0	3.1 **
Ind. Var.									
03	VVMNNG	19.0	5.4	9.4	4.5 **	25.6	4.7	11.7	5.4 **
04	VPICTR	18.0	4.3	14.0	4.2 **	24.0	4.9	17.5	4.0 **
05	SPATRL	16.6	4.0	11.8	4.5 **	17.6	3.9	14.2	4.5 **
06	VISCON	17.8	4.1	9.3	4.2 **	20.8	3.4	12.6	4.3 **
07	RSNGFG	18.0	3.8	12.6	4.9 **	19.9	3.6	16.4	4.2 **
08	PRCPTN	20.4	6.5	14.3	7.1 **	26.3	7.4	20.5	8.1 **
09	RINFOR	20.7	4.5	14.8	3.8 **	24.2	4.5	16.8	4.4 **
10	AUDING	78.8	12.1	61.6	15.2 **	95.6	13.0	75.3	15.7 **
11	AUDCON	7.7	2.3	2.4	2.3 **	8.2	2.2	4.1	2.8 **
12	AFFIXS	22.1	7.5	14.3	4.9 **	32.3	7.2	15.7	5.2 **
13	WDRCTX	46.1	10.8	18.9	9.1 **	52.4	7.4	27.3	11.6 **
14	MSNDWD	43.6	12.9	18.8	8.7 **	52.4	8.2	22.9	9.4 **
15	BLWRDS	33.7	6.6	18.8	6.4 **	38.3	5.0	24.6	7.7 **
16	PHONIC	22.0	11.5	10.7	3.8 **	33.0	11.7	12.8	6.3 **
17	SYLLAB	5.5	3.1	1.9	1.4 **	7.6	3.4	2.7	2.1 **
18	AUDABS	16.1	6.0	6.2	4.7 **	18.4	4.6	9.1	4.9 **
19	SPLREC	40.2	10.1	22.0	7.4 **	48.5	10.1	27.6	8.8 **
20	SPDWRD	33.8	9.8	23.6	8.2 **	44.4	11.5	29.2	12.0 **
21	RAFFRT	24.9	8.6	12.5	7.7 **	30.7	10.3	17.7	7.7 **
22	RVRSLS	11.3	6.0	5.4	4.7 **	15.5	5.8	7.7	5.7 **
23	VVABST	13.3	5.8	5.4	5.2 **	18.9	6.7	11.0	6.8 **
24	DOTFGD	48.4	10.3	48.4	12.3	53.8	12.5	52.2	11.4
25	CUESYC	22.8	8.1	21.7	8.5	28.5	8.8	24.4	8.9 **
26	PITCHD	16.8	4.8	14.0	3.5 **	19.2	5.5	15.5	4.4 **
27	RHYTHM	15.8	3.4	14.2	3.0 *	17.5	2.5	15.3	3.1 **
28	INTNST	13.7	4.2	12.1	4.3 *	15.8	3.7	13.6	4.3 **

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.

TABLE Q--CONTINUED

RAW SCORE MEANS AND STANDARD DEVIATIONS FOR LEAST VS. MOST POWERFUL READERS IN GRADES 3 THROUGH 6

No.	Name	Grade 5				Grade 6			
		Most Powerful N = 63		Least Powerful N = 68		Most Powerful N = 35		Least Powerful N = 36	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dep. Var.									
01	SPEED	29.4	8.7	15.3	5.7 **	40.3	8.6	17.3	7.1 **
02	POWER	31.2	3.7	8.2	4.3 **	34.4	2.2	9.2	5.1 **
Ind. Var.									
03	VVMNNG	30.7	4.2	15.5	5.6 **	34.1	1.7	17.6	6.2 **
04	VPICTR	28.5	3.7	19.4	4.7 **	31.5	3.5	21.5	5.8 **
05	SPATRL	18.9	3.9	16.3	3.9 **	20.9	3.3	16.6	3.8 **
06	VISCON	22.2	3.6	14.3	4.2 **	23.0	2.5	14.9	4.1 **
07	RSNGFG	21.0	3.8	18.3	3.9 **	22.8	2.3	18.7	3.7 **
08	PRCPTN	26.9	7.6	22.1	8.1 **	34.2	8.2	26.5	7.7 **
09	RINFOR	29.5	3.4	20.2	4.5 **	31.4	3.2	21.9	6.3 **
10	AUDING	103.8	8.0	84.2	13.6 **	107.4	7.4	85.0	16.3 **
11	AUDCON	9.4	1.9	4.9	2.4 **	10.0	1.4	4.9	3.3 **
12	AFFIXS	38.7	7.4	18.7	5.7 **	43.5	4.7	22.4	8.2 **
13	WDRCTX	54.2	5.9	30.2	12.4 **	56.4	7.0	34.0	11.5 **
14	MSNDWD	56.5	4.5	30.5	13.2 **	57.6	2.5	33.0	12.7 **
15	BLWRDS	39.0	4.0	25.6	7.7 **	40.4	2.5	27.5	8.5 **
16	PHONIC	38.7	8.2	17.1	8.6 **	41.8	7.0	18.1	7.5 **
17	SYLLAB	8.6	3.6	3.6	2.4 **	10.2	2.6	4.4	2.8 **
18	AUDABS	19.1	4.7	11.2	5.9 **	21.0	3.4	12.3	5.2 **
19	SPLREC	52.3	9.2	32.7	10.0 **	59.0	5.0	35.9	11.1 **
20	SPDWRD	48.6	13.5	37.5	12.1 **	63.0	13.8	41.6	12.6 **
21	RAFFRT	34.6	8.6	25.3	8.7 **	40.5	6.6	26.9	9.8 **
22	RVRSLS	19.1	7.5	10.5	6.1 **	25.2	8.5	11.9	7.3 **
23	VVABST	23.5	8.1	15.5	8.9 **	27.2	8.2	17.3	8.4 **
24	DOTFGD	56.5	10.9	51.5	11.6 *	61.9	10.9	55.9	12.2 *
25	CUESYC	32.5	9.4	27.8	8.0 **	40.1	10.6	30.9	9.1 **
26	PITCHD	20.0	5.2	17.2	3.9 **	22.0	4.5	18.7	5.1 **
27	RHYTHM	17.8	2.5	16.1	2.6 **	18.9	2.8	18.0	2.5
28	INTNST	17.0	2.6	14.9	2.9 **	18.2	2.3	14.9	3.4 **

*Differences significant at the five per cent level.
**Differences significant at the one per cent level.